Adaptation to Climate Change in Agriculture: Success stories

Professor Kadambot Siddique,
Hackett Professor of Agriculture Chair and Director
The UWA Institute of Agriculture, The University of Western Australia
T: +61 8 6488 7012 • M: +61 411 155 396 • E: kadambot.siddique@uwa.edu.au

28 April 2026

Overview

- Background
- Definition of Adaptation
- Western Australian dryland agriculture
- Past and Future Climate Changes (rainfall, temperature & CO_2)
- Adaptation to climate change-past & future
- Greenhouse gas emission
- Case studies (Australia, China and India)
- Conclusions

Perth, Western Australia

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UWA's global reputation

Study at an internationally recognised university

Ranked in the world's top 100

Well-established industry partnerships

GROUP OF EIGHT AUSTRALIA MEMBER

UWA is a member of the **'Group of Eight'** – a coalition of the best research-intensive universities in Australia.

Professor Barry Marshall
Nobel Laureate

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- **UWA medicine graduate, 1974**
- **Nobel Prize for Medicine or Physiology, 2005**
- **Director of The Marshall Centre for Infectious Diseases Research and Training**
- **Professor of Clinical Microbiology**


13th in the world
1st in Australia
for Agricultural Sciences
Academic Ranking of World Universities 2025

The UWA Institute of Agriculture
Annual Research Report 2024

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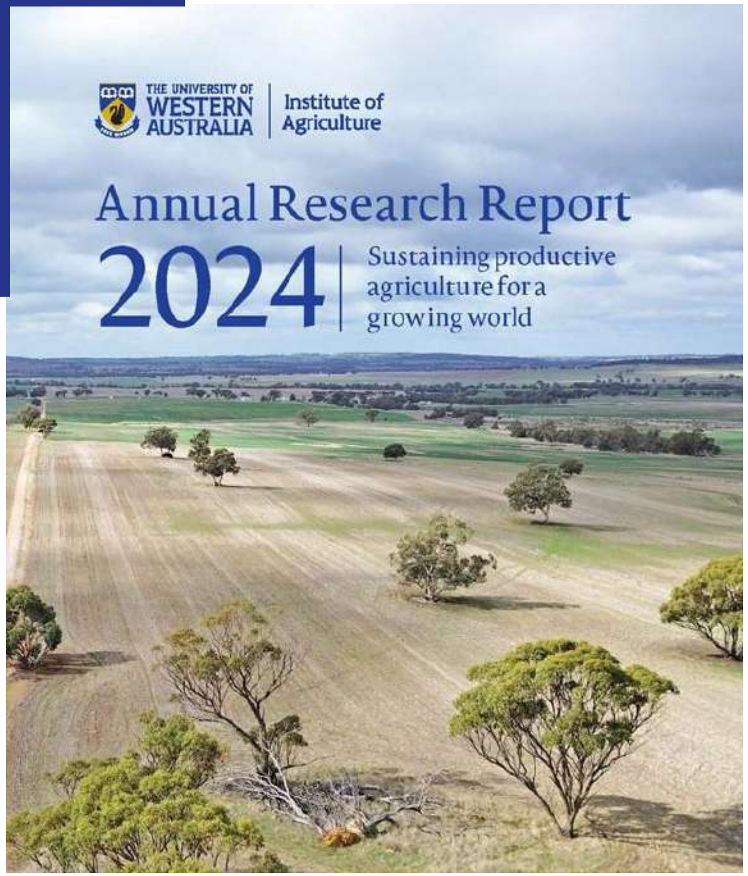
https://www.uwa.edu.au/institutes/institute-of-agriculture/-/media/uwa-institute-of-agriculture/documents/annual-reports/ioa-annual-research-report-2024.pdf

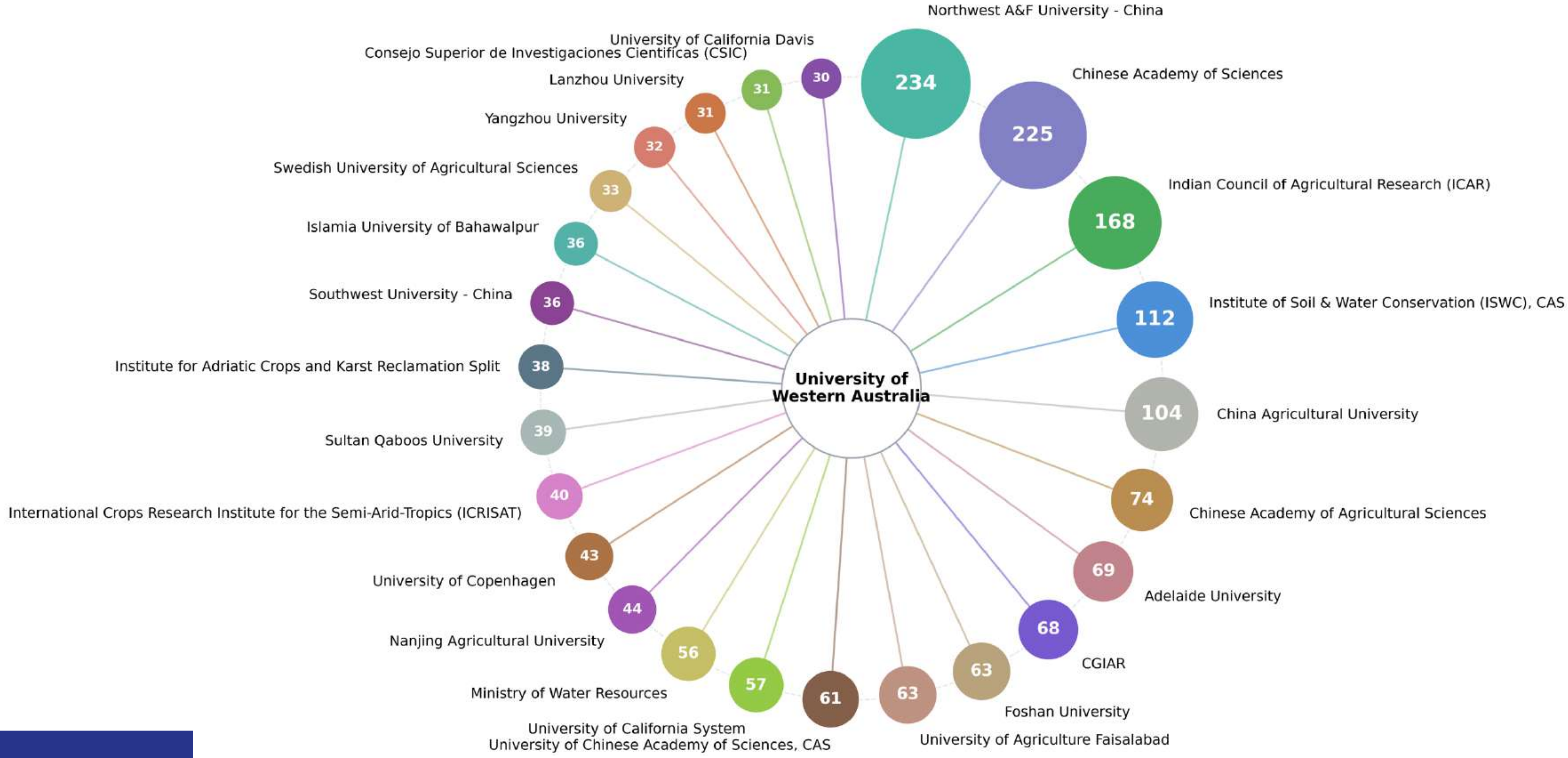


UWA's Key Collaborators

Global

2020-2026

Research Area: 30 Agriculture

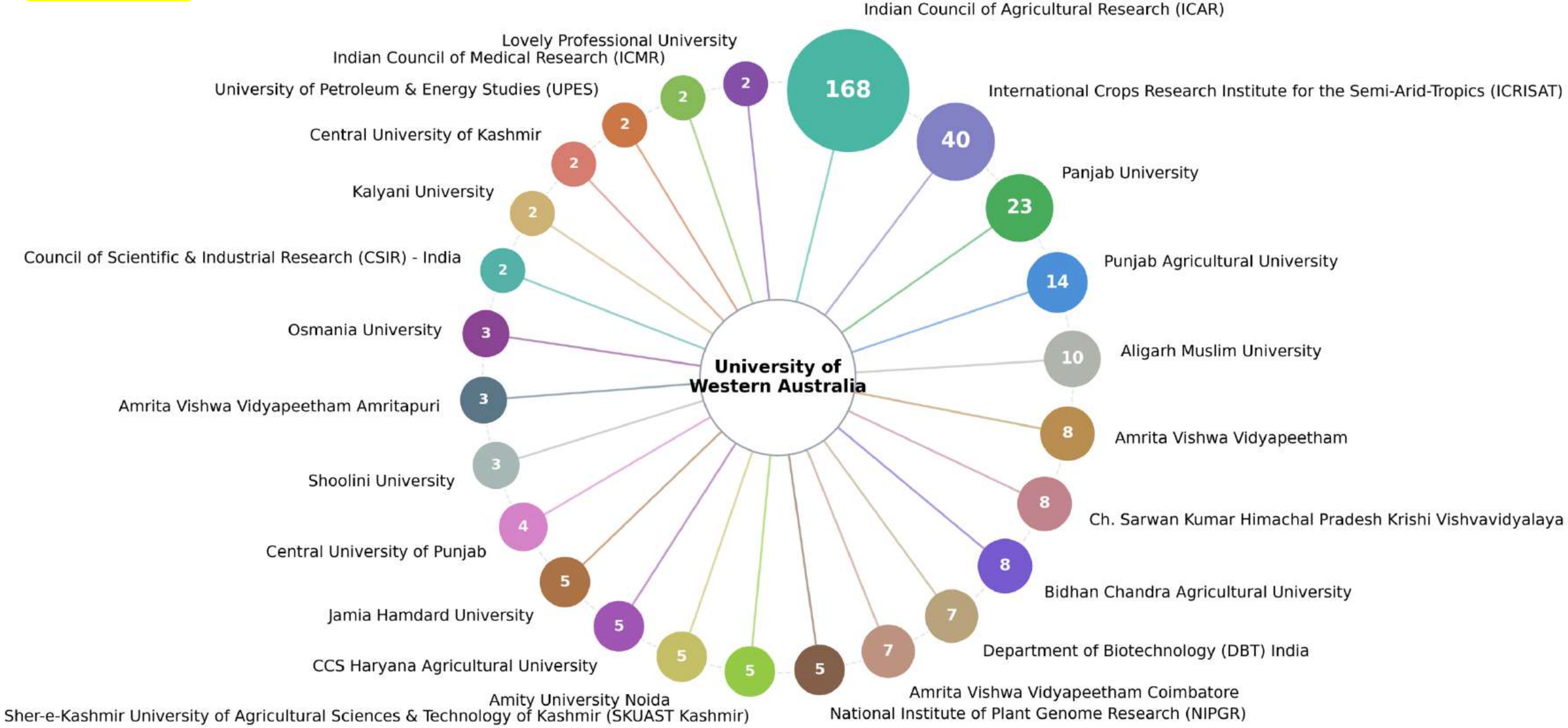


UWA's Key Collaborators

Indian Institutions

2020-2026

Research Area: 30 Agriculture



My International collaborations 2026


My PhD students at UWA

Food Ecology

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- Sustainable Agriculture • Soil Health • Water & Ecosystem Management
- Food Science • Nutrition • Food Safety • Climate-Smart Agriculture
- Biotechnology • Genomics • Microbiology • Precision Agriculture
- Circular Bioeconomy • Policy • Biodiversity • Sustainable Food Systems

Manuscript types

- Research Article • Review • Mini Review • Short Communication
- Research Highlight • Perspective

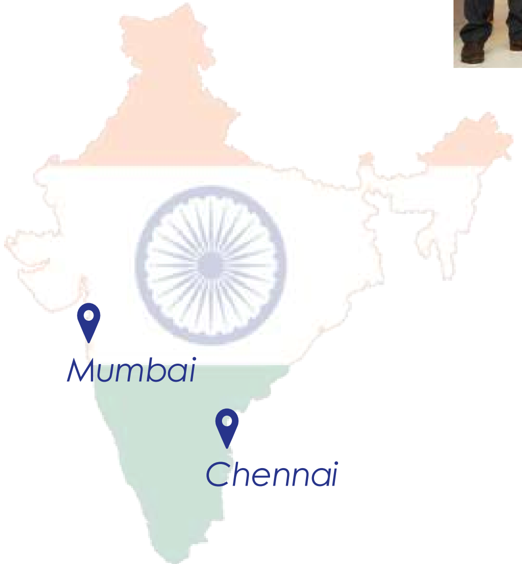
Why Choose Us?

- High Starting Point: Target IF 25
- **Full APC Waived (Until 2027)**
- Fast-Track & Priority Publication
- Global Promotion (EurekAlert, AlphaGalileo, Twitter, etc)
- High Visibility & International Impact

The Go8 is Coming to India

The University of Western Australia (UWA) is preparing to bring world-class education and research to India.

- **UGC approval**: UWA became the **first Group of Eight university** approved to establish campuses in India.
- It is the only Foreign University establishing 2 campuses in the top 2 economies in India – Chennai and Mumbai.
- Our planned campuses will offer a diverse portfolio of undergraduate and master's degree programs, beginning with:
  - **Science, Technology, Engineering and Mathematics (STEM)**
  - **Business and Commerce**
- This is the first phase of rollout with an aim to look at the needs of the Indian economy and support a diversity of courses.
- **MoU with Science and Technology Clusters for the Office of the Principal Scientific Advisor to Hon. Prime Minister of India**: around collaboration in research, science and technology initiatives centred on agritech, med tech and blue economy in phase 1.
- **Micro credential collaboration:** building jointly recognised dually awarded micro credentials in AI & Cyber Security with HCL Tech and Tailings & Critical Minerals with Federation of Indian Mining Association.



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Progress to Date

Significant progress has been made since the August 18 Briefing across governance, academic, commercial and operational areas to position UWA for the successful establishment of the India IBC.

1. **Sites secured in Chennai and Mumbai** a tangible milestone, showing commitment in-market.
2. **Staff recruitment underway** including the appointment of the Chief Operating Officer, Mr David Das
3. **Application are live on** india.uwa.edu.au for students to apply for courses.
4. **UWA** have established global engagement offices to establish stronger and deeper partnerships across India.
5. **Call to action:** Encourage students to apply now on the portal; encourage talent to apply for jobs advertised on the UWA India portal; encourage strategic partnership / collaboration opportunities through the UWA India portal – live now ☺

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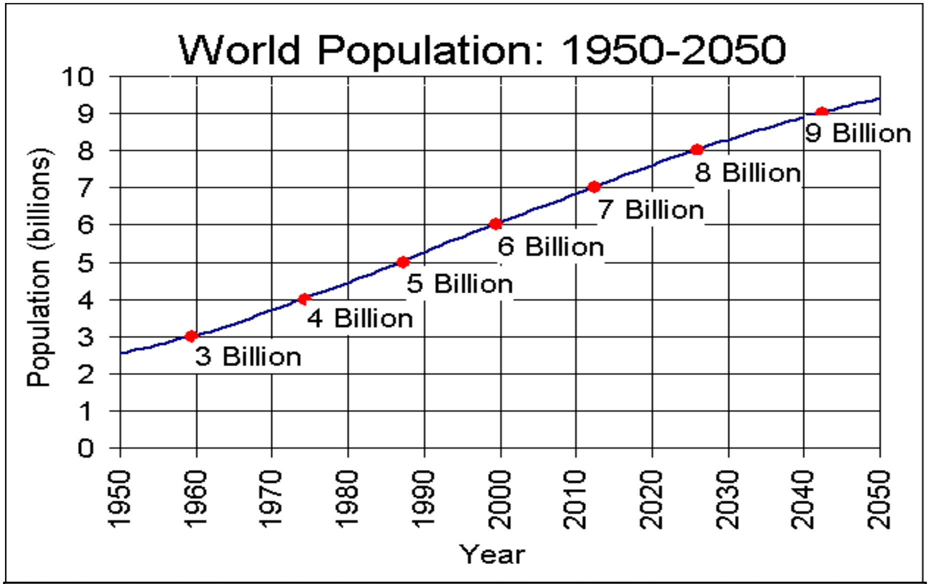
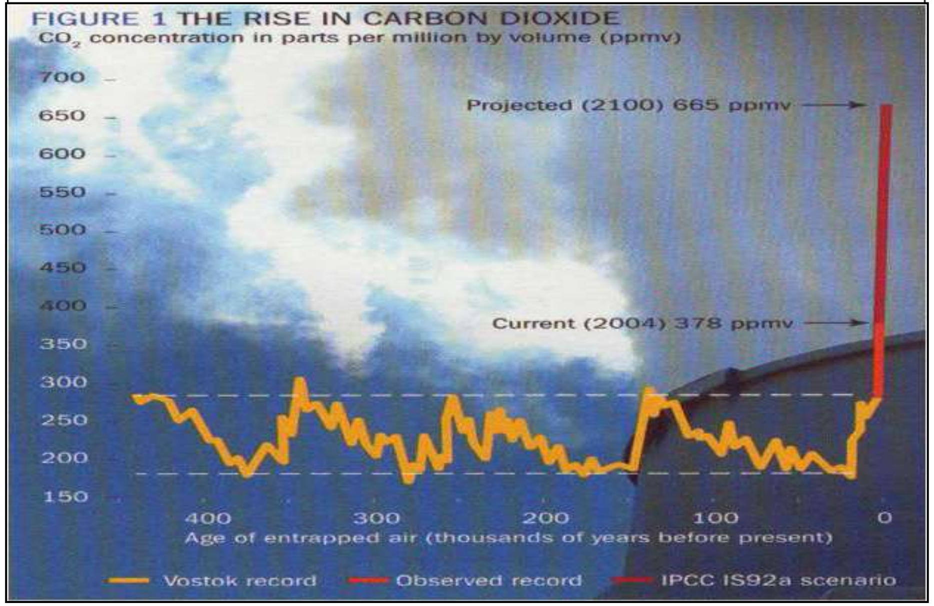
Five global challenges





1. Feed the increasing world population;
2. Meet projected energy demands;
3. Manage greenhouse gas emissions and adapt to climate change/ variability;
4. Preserve natural ecosystems and biodiversity;
5. Maintain global security.

Adaptation

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Adaptation is defined as: "*adjustments made in response to stress*"

Adaptation should be based on process to minimise the potential negative impacts of variable climate;

Successful adaptation enhances a system's ability to deal with uncertain future change.

Top 50 Countries – agricultural land

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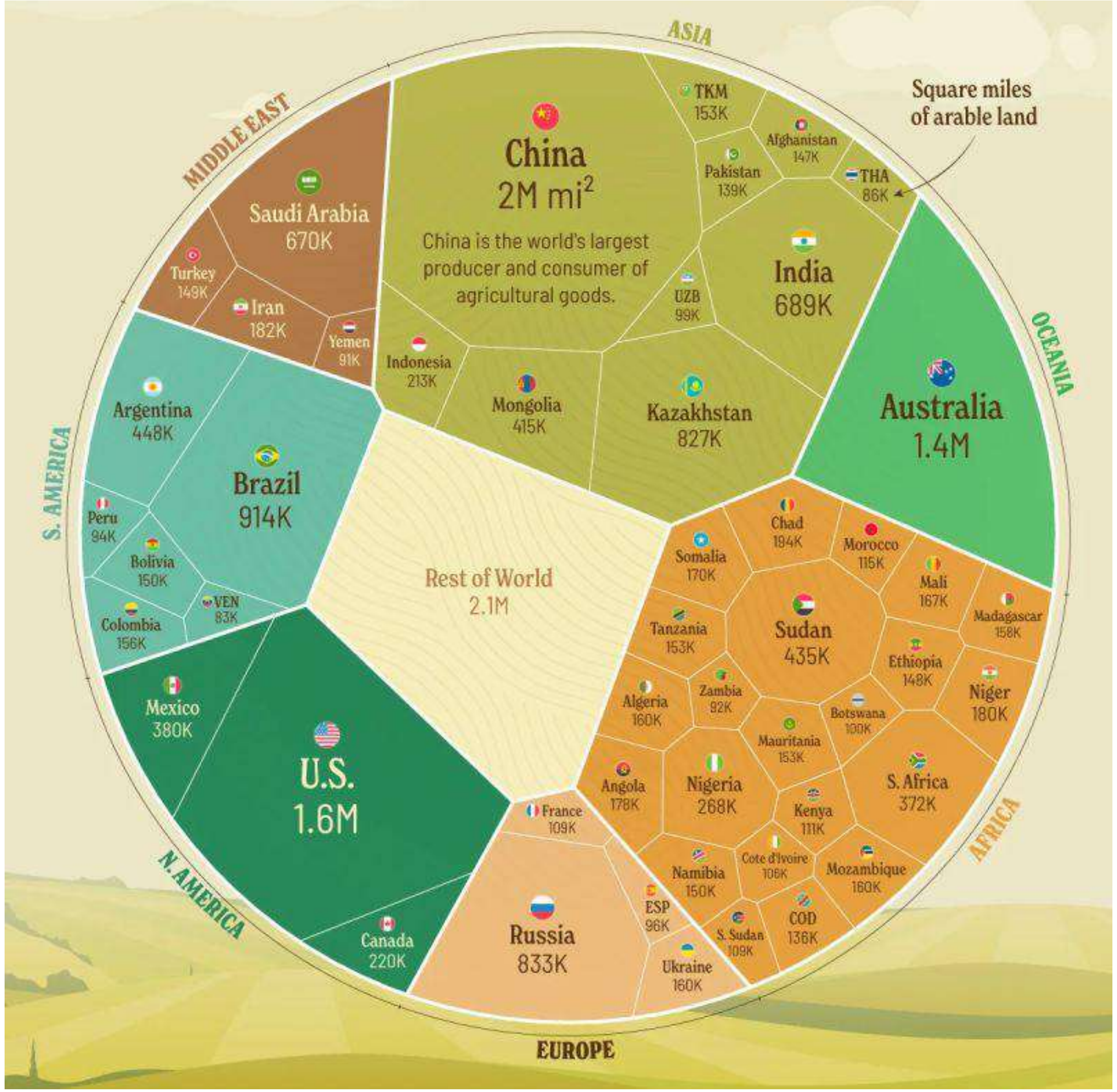
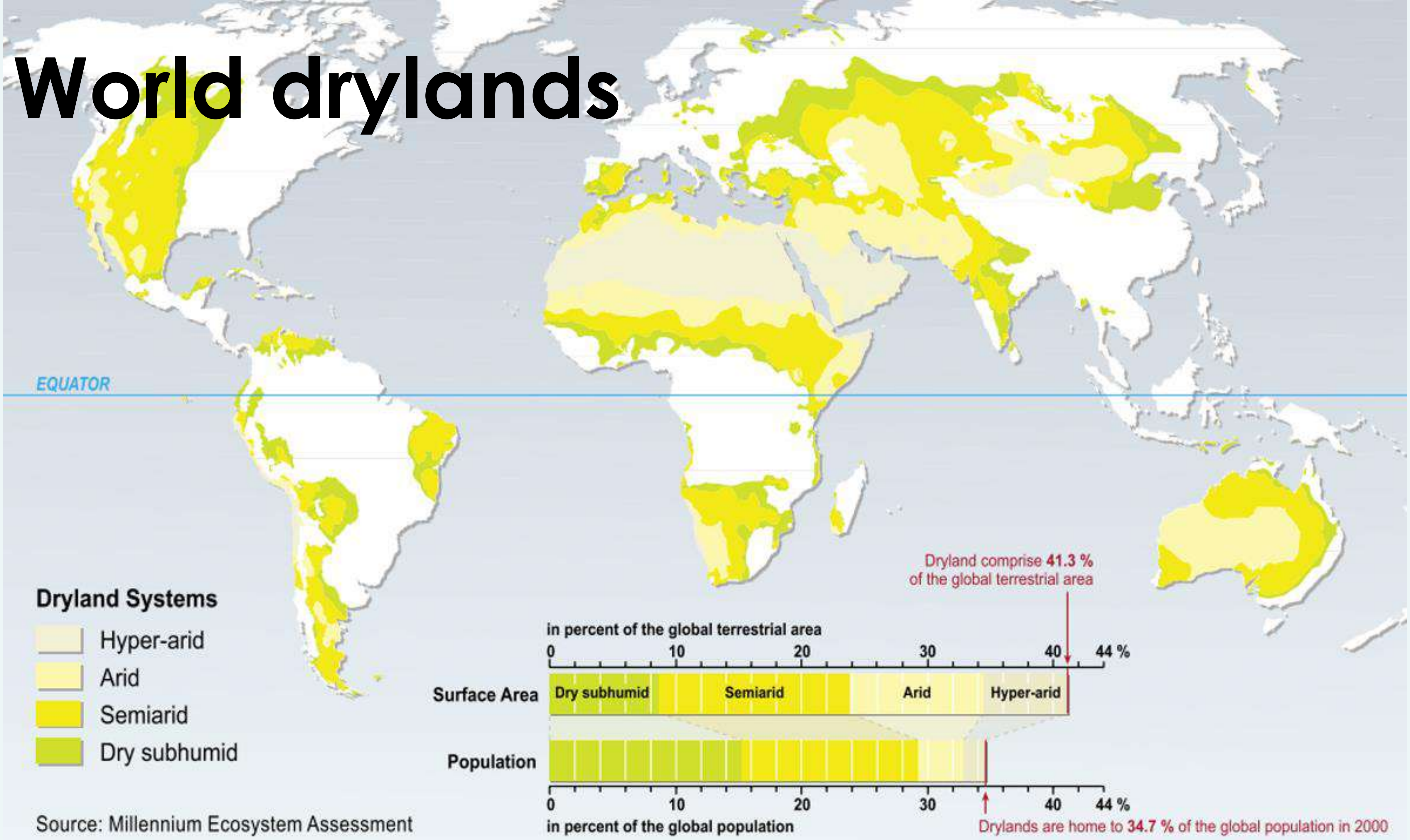
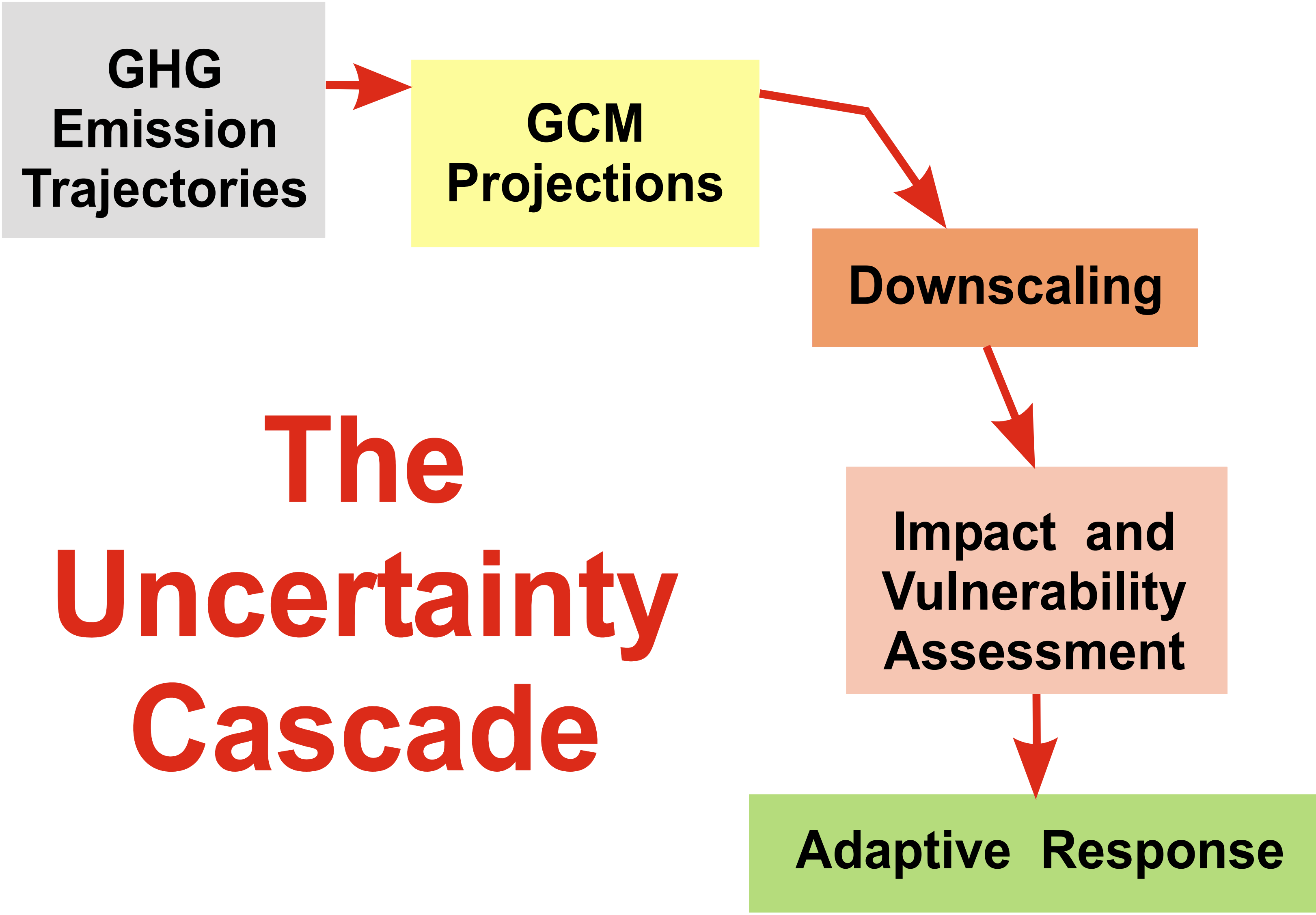


Globally there are 18.1M mi² of arable farm land, roughly equal to the size of two North Americas.

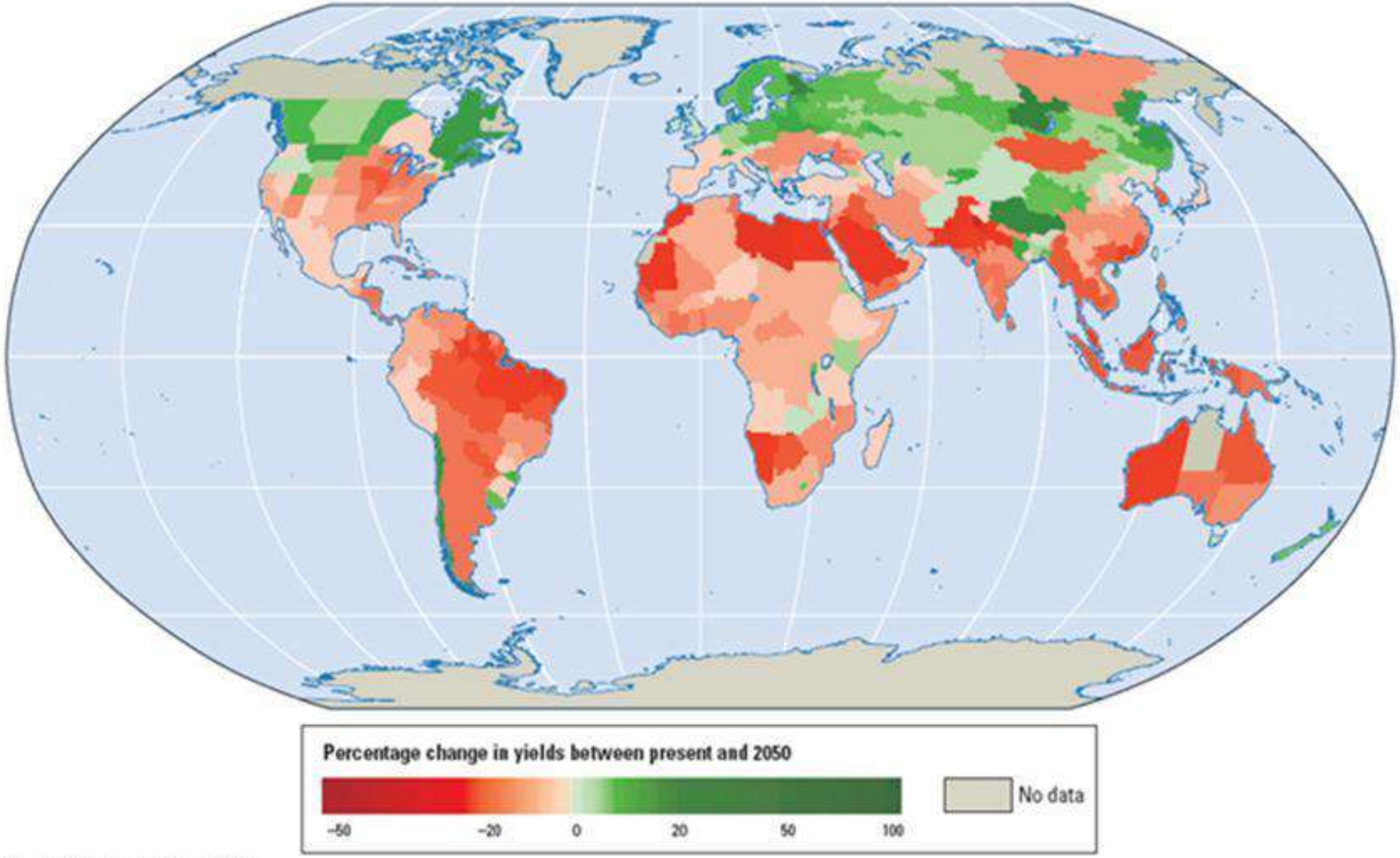
World drylands



Climate change and adaptation



Climate change will depress agricultural yields in most countries by 2050 given current agricultural practices and crop varieties



Source: Müller and others 2009.

Note: The figure shows the projected percentage change in yields of 11 major crops (wheat, rice, maize, millet, field pea, sugar beet, sweet potato, soybean, groundnut, sunflower, and rapeseed) from 2046 to 2055, compared with 1996–2005. The values are the mean of three emission scenarios across five global climate models, assuming no CO_2 fertilization (see note 54). Large negative yield impacts are projected in many areas that are highly dependent on agriculture.

Global production of primary crops

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WORLD'S AGRICULTURE PRODUCTION

Global production of primary crops has generally increased since 2010, with almost all crop categories recording double-digit growth, according to latest FAO data. The global area harvested increased by 197 million hectares between 2010 and 2024, to 1.5 billion hectares. While oil crops, roots and tubers, pulses and vegetables showed predominantly area-driven growth, improved yields primarily drove the growth of cereals, fruits and sugar crops production...

Major primary crops: Production and area, 2024

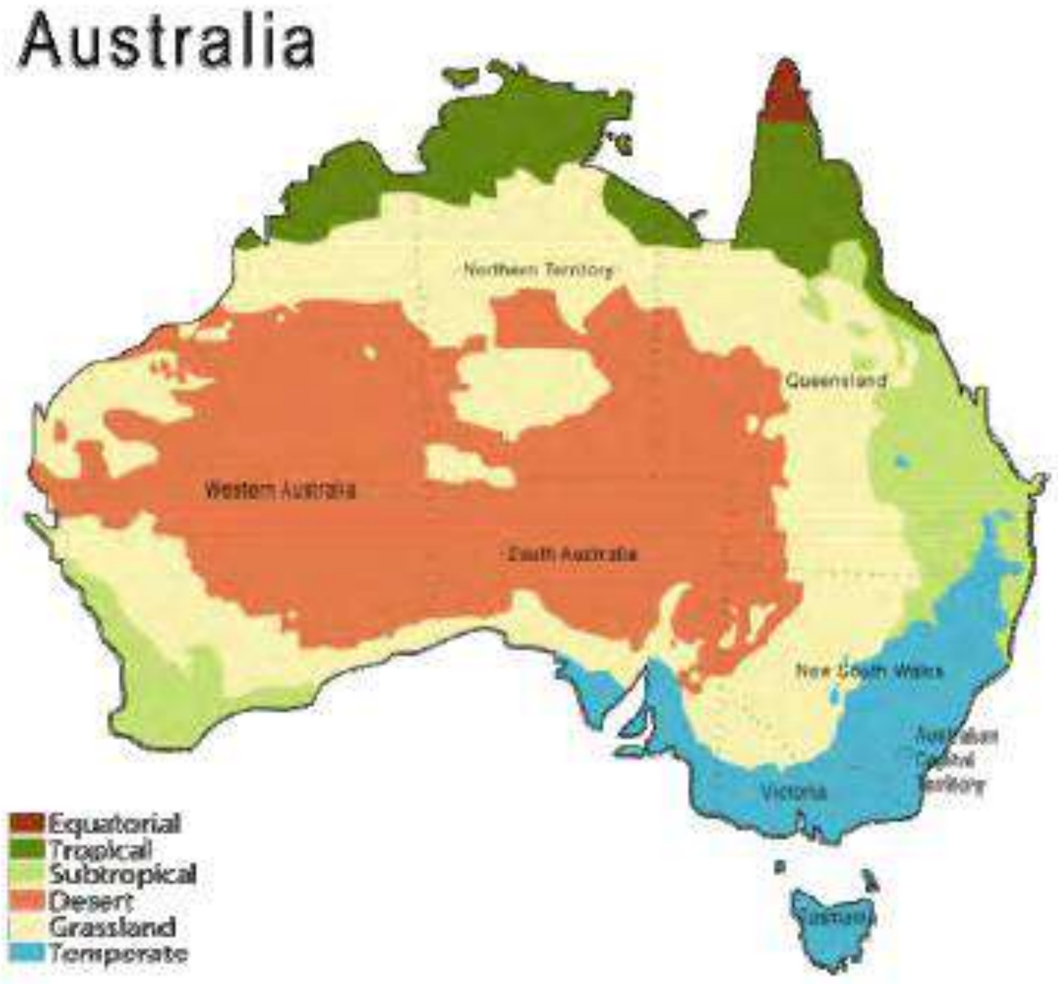
	Production (million tonnes)			Area harvested (million hectares)		
	World	% change*	India share	World	% change*	India share
Cereals	3,133.2	26.8	12.5	745.0	7.4	14.5
Sugar Crops	2,234.3	17.2	20.3	31.5	11.1	18.2
Oilcrops	1,197.0	49.0	6.1	351.9	28.7	12.6
Vegetables	1,182.1	25.8	12.4	59.6	17.1	15.4
Fruit	953.8	29.4	11.8	68.4	12.8	10.3
Roots & Tubers	944.1	26.5	7.0	72.0	32.4	3.7
Pulses	97.1	33.2	26.2	91.2	16.7	30.7
Fibre Crops^	32.3	9.7	21.0	34.1	-1.9	35.5
Treenuts	18.4	42.4	6.1	14.4	40.2	9.0

*Over 2010; ^Fibre Equivalent

Source: Agricultural production statistics 2010-24

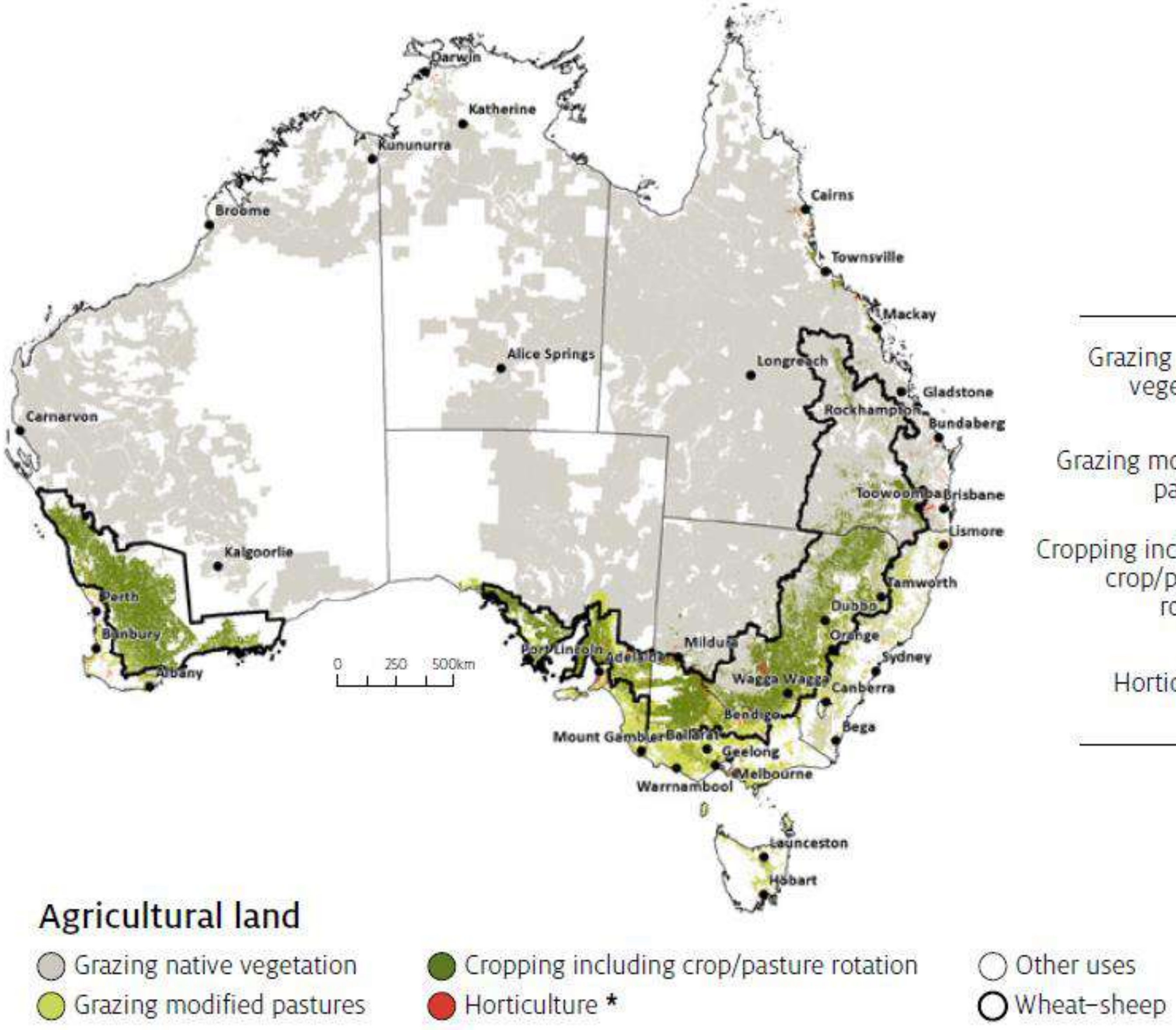
Australia: wide range of climate

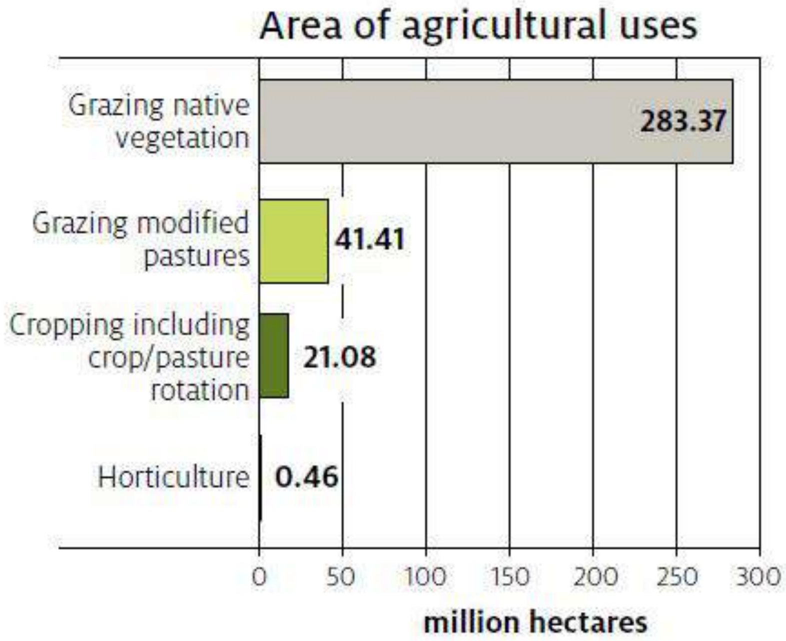
- Equatorial
- Tropical
- Subtropical
- Desert
- Grassland
- Temperate



Source: Farm Weekly 01/2012

Agricultural production zones





Source: ABARES Insights March 2023

Australian agriculture is export oriented

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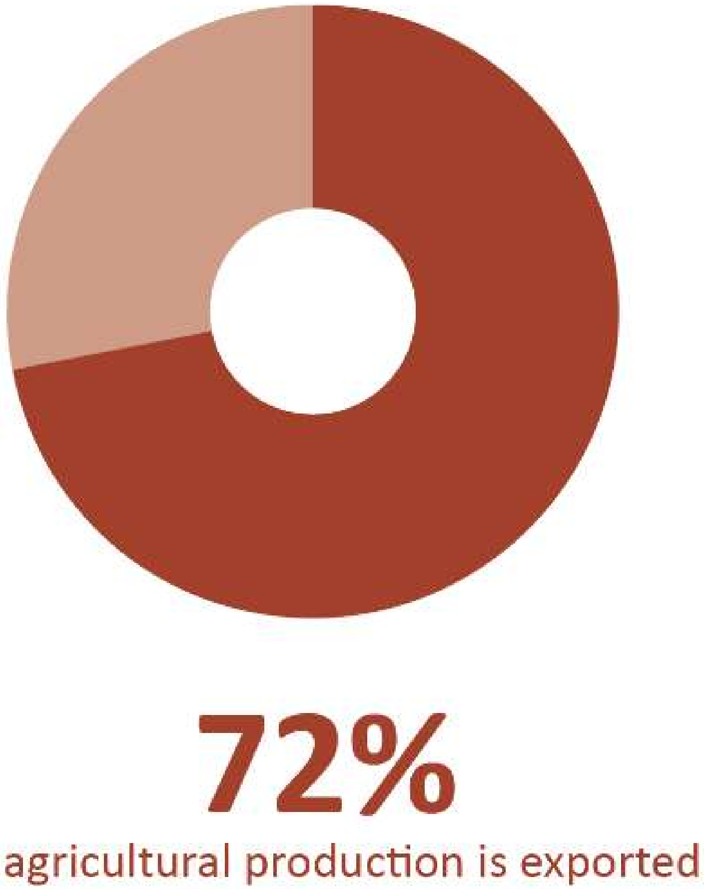
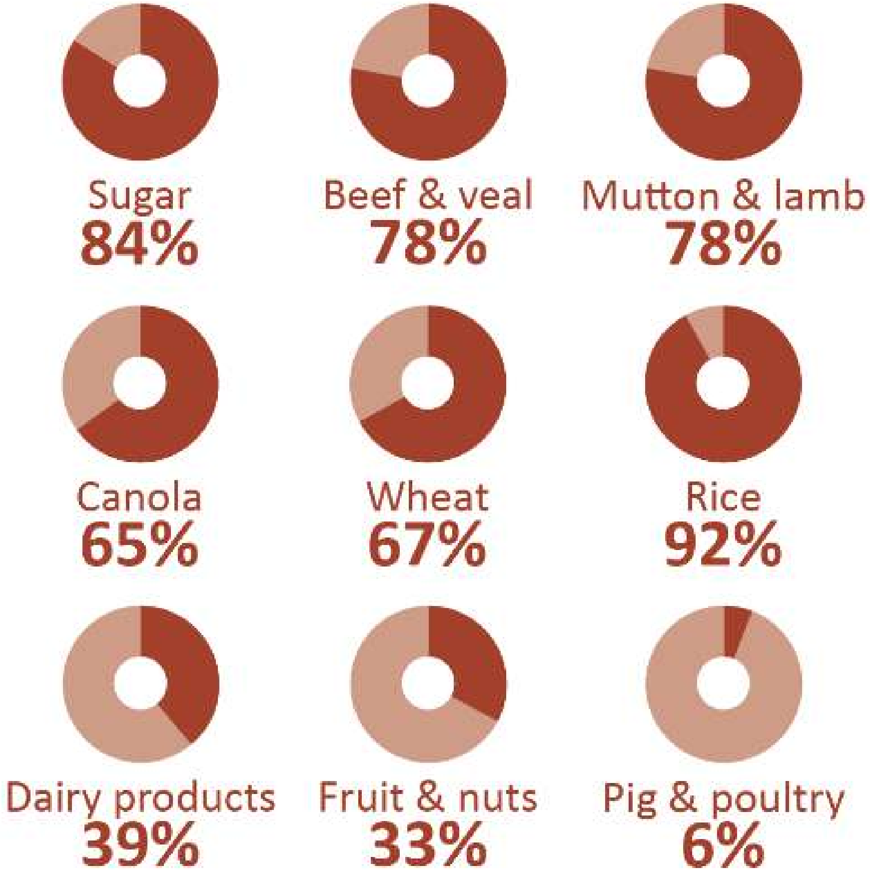




Source: ABARES Insights Snapshot of Australian Agriculture 2024

The West Australian

Agriculture Climate Change Countryman Environment Retail

Climate change driving up food prices with warning bare shelves to become more common, new report warns

The rural network

Farmers' report warns climate crisis puts Australia's food supply at increasing risk

CLIMATE CHANGE HURTING SUPPLY CHAINS

MATT JOHNSTON

THE price of meat, bread, dairy and fruit is being driven up by climate change's impact on food supply chains and the hip pocket pain is set to get worse.

A new report commissioned ... Bartos, examines the impact of lost food, less water, and fewer days to transport livestock as some of the factors contributing to cost increase.

... will be times when supply chain risk management plans will be overwhelmed and fail, and parts of Australia will run out of food," he said.

Climate change forcing up food cost: report

AUSTRALIANS can expect more expensive groceries and more empty supermarket shelves thanks to climate change, according to new research.

The Fork in the Road report, released on Wednesday by Farmers for Climate Action in the shadow of the nation's ongoing flood crisis,

... be transported in extreme heat - mean consumers pay more for food," she said.

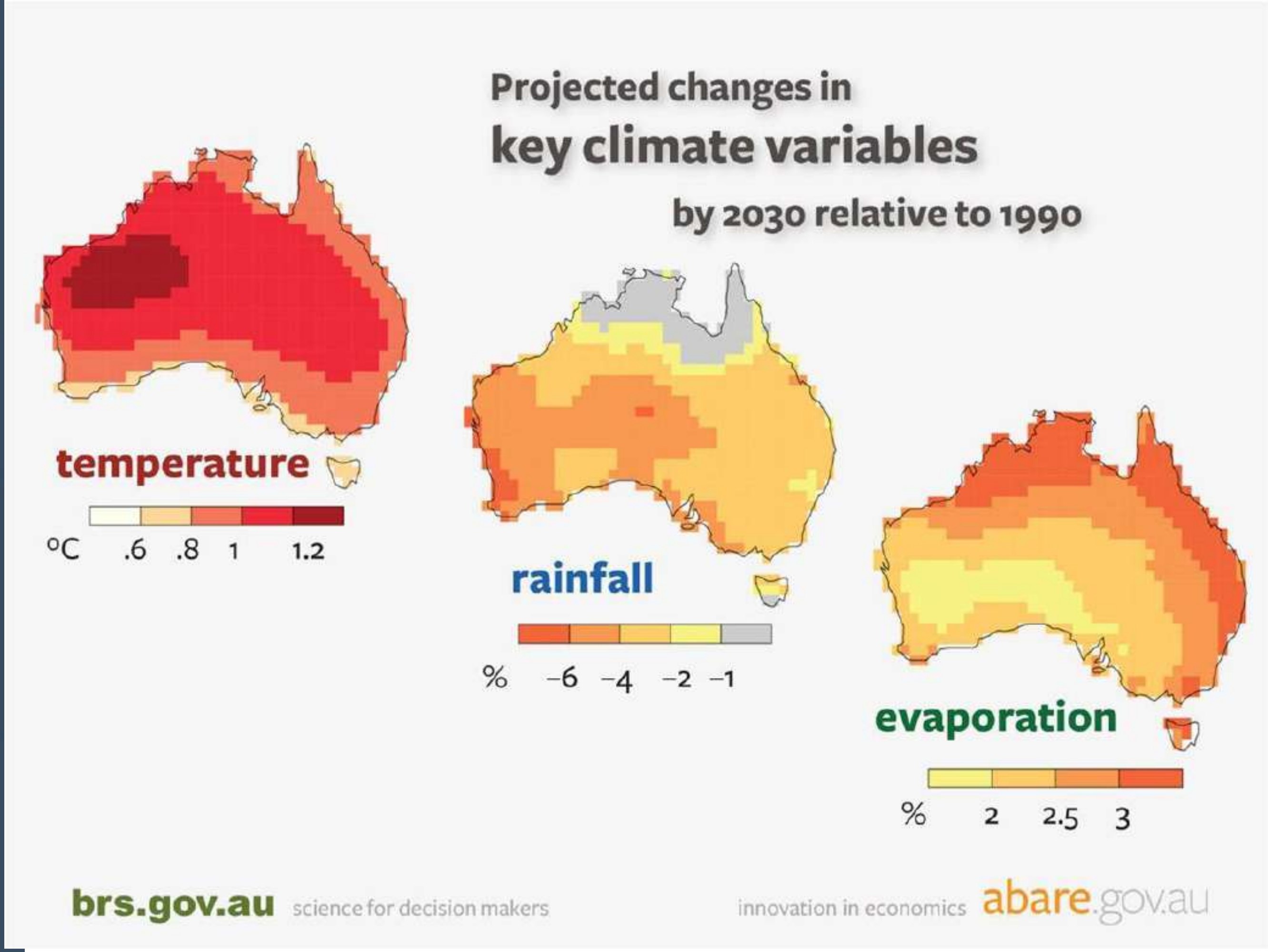
Meanwhile, charities are feeling the impact of supply chain issues and the rising cost of living from COVID, natural disasters and overseas conflict.

Ronni Kahn - founder and CEO of OzHarvest, a service which rescues surplus food and delivers it to people in

Aussies paying more for groceries as climate change disrupts supply chains: Farmers for Climate Action report

Jamieson Murphy
@jamiesonmurph

farmers for climate action



Mediterranean zone of Australia

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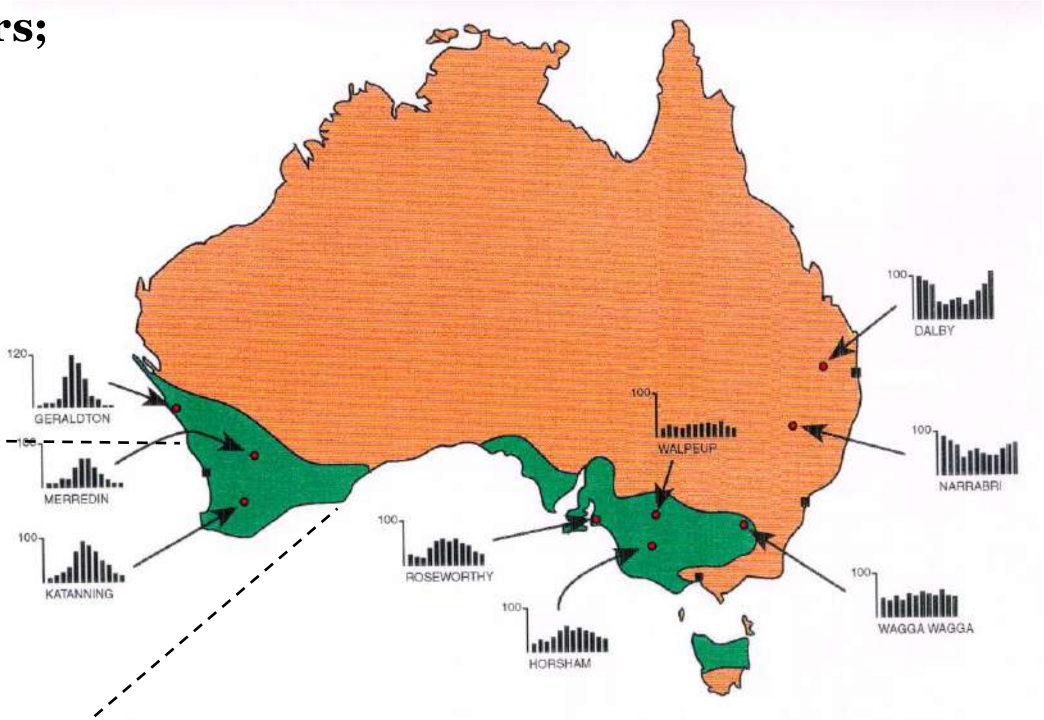
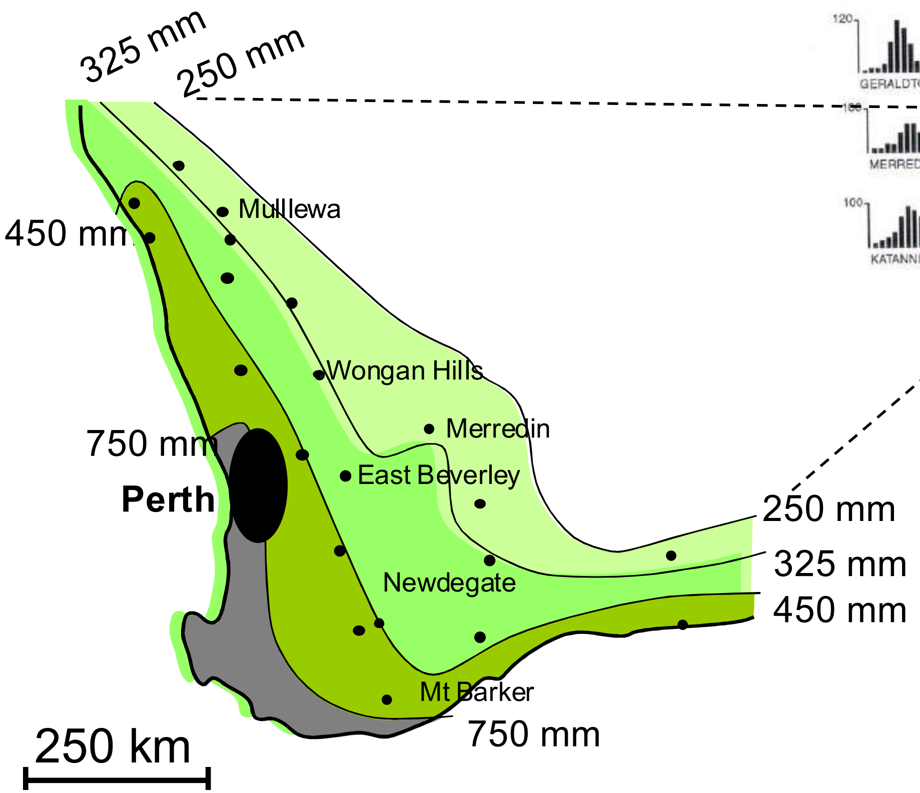
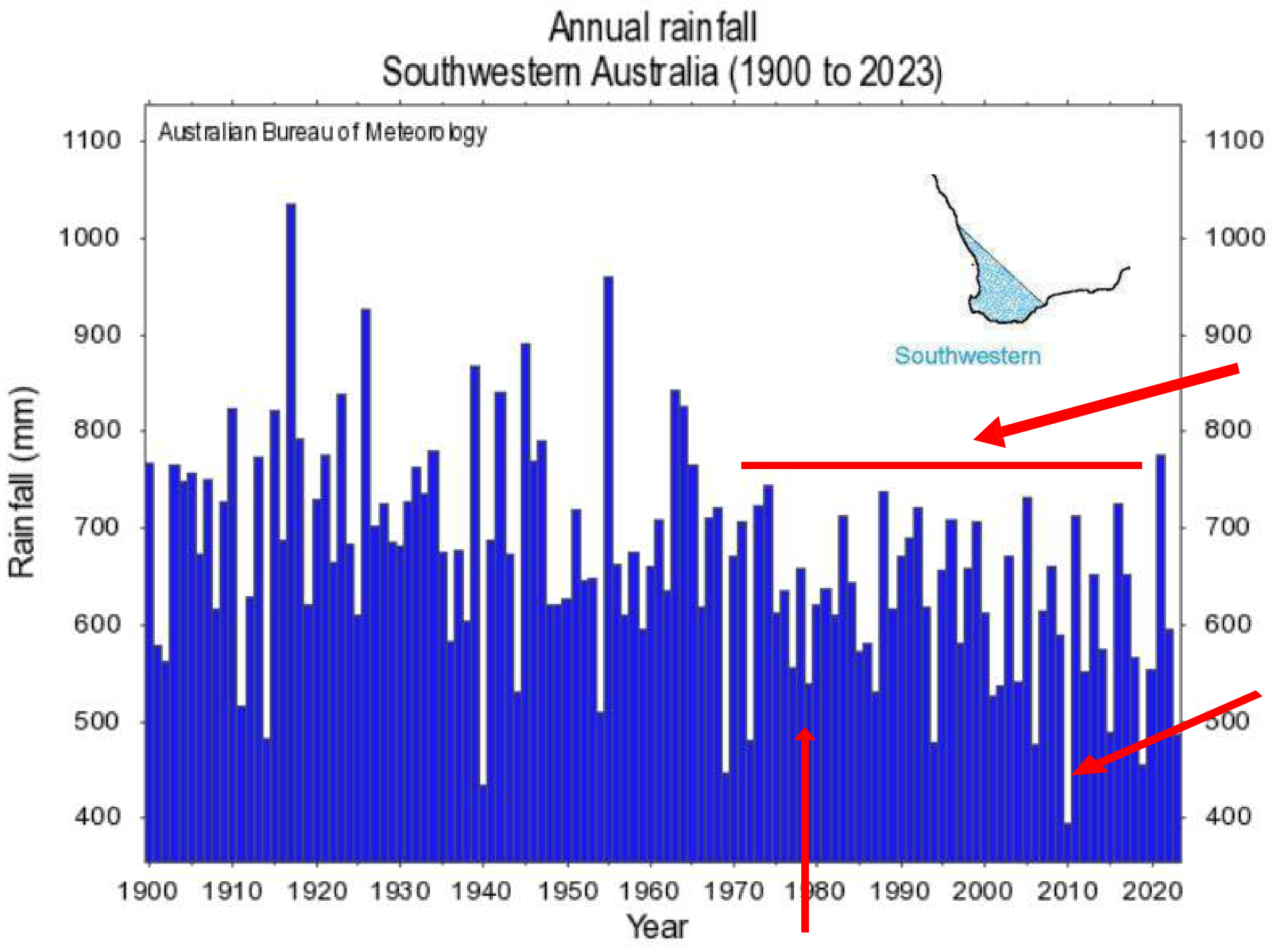
- **Climate: cold wet winters and hot dry summers;**
- **16 million ha of arable land in WA;**
- **4,000 farmers, average farm size 4,000 ha**





- **Wheat, barley, canola, grain and pasture legumes and sheep**

Rainfall southwestern Australia



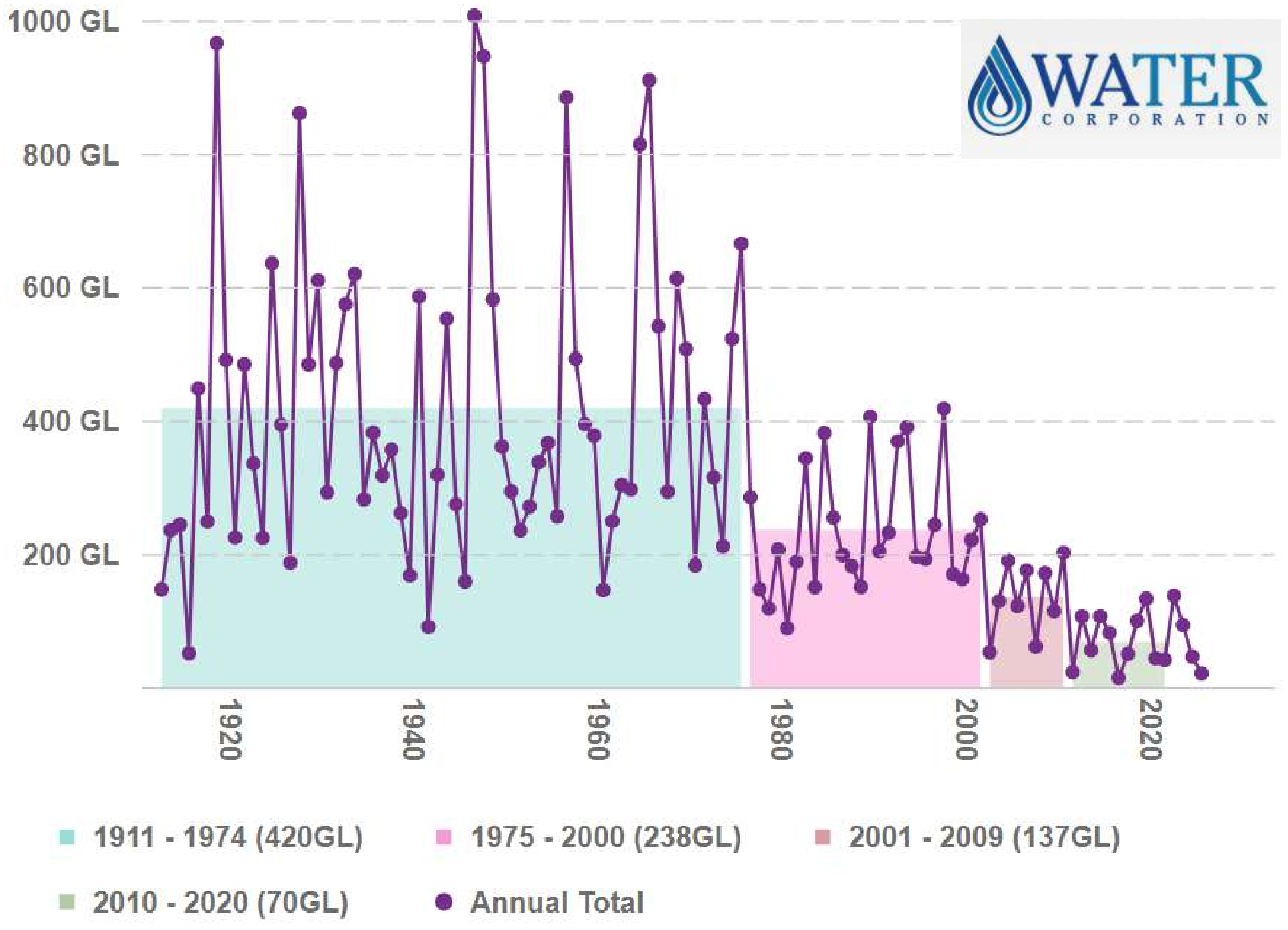
Lack of very wet years & decrease in variability

2010 - driest year on record

Significant drop in rainfall in southwest WA in the mid 1970's

Source: Bureau of Meteorology

Impacts SW WA dam inflows



https://www.watercorporation.com.au/water-supply/rainfall-and-dams/streamflow/streamflowhistorical

SW WA is getting hotter

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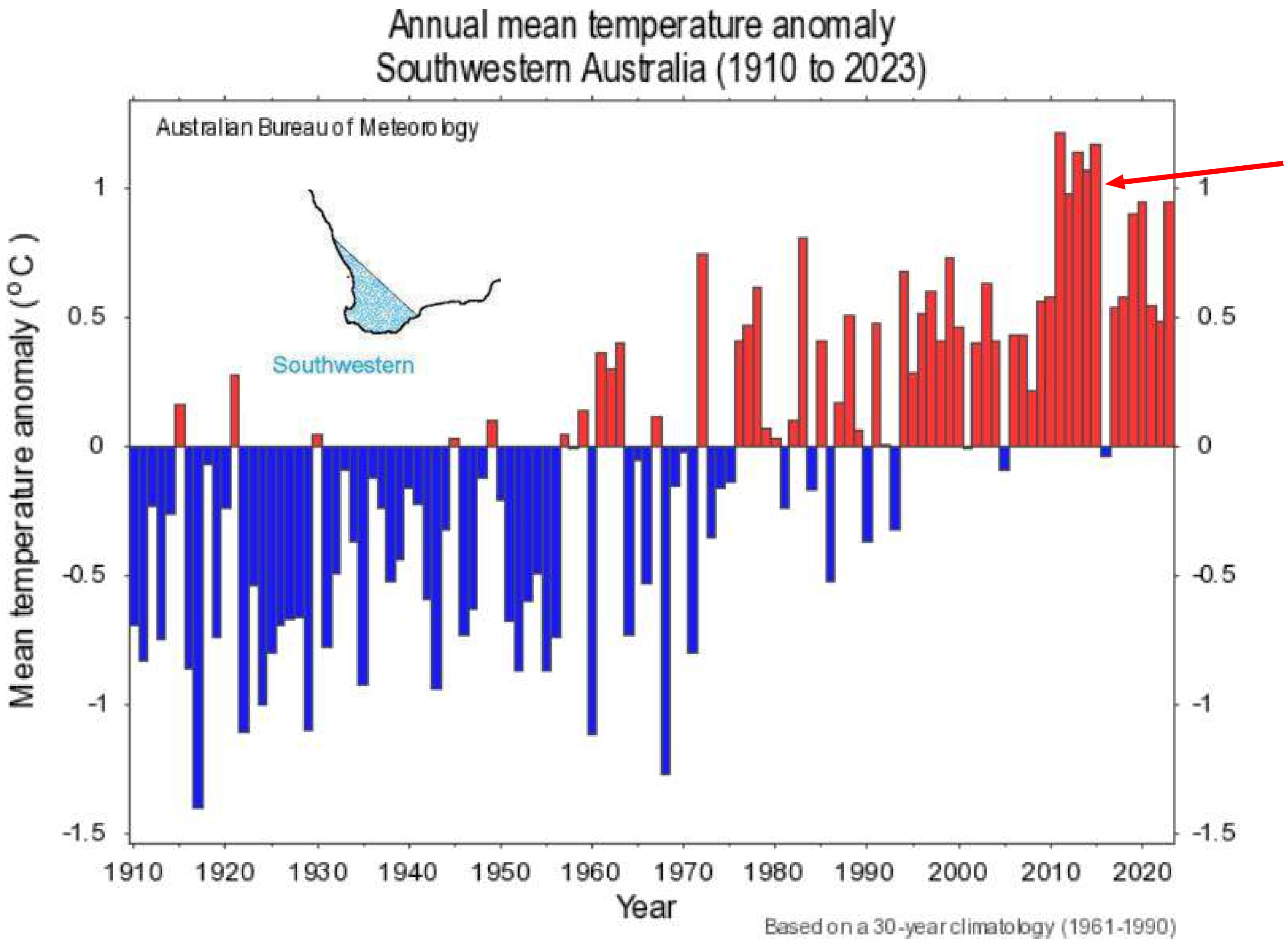

Four hottest years on record

Source: Bureau of Meteorology

http://www.bom.gov.au/cgi-bin/climate/change/timeseries.cgi?graph=tmean&area=swaus&season=0112&ave_yr=0&ave_period=6190

Australian agriculture & climate change

- Lower average autumn & winter rainfall
- Increased seasonal variability
- Increased risk of prolonged drought
- Higher average temperatures and evaporation rates
- More intense tropical cyclones

“Big” questions in climate change and agriculture

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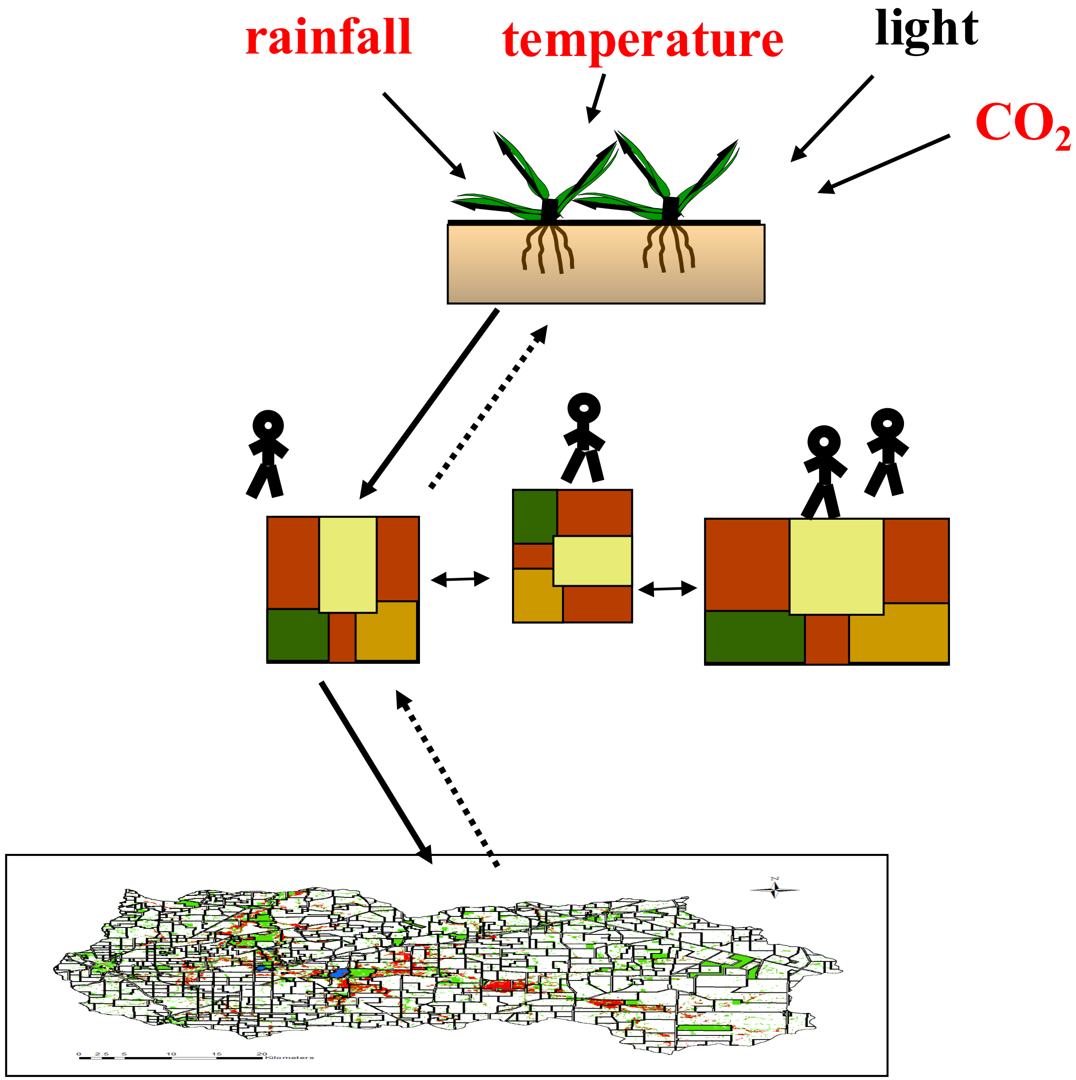
- What is the impact of climate change on agriculture?
- What are the risks & opportunities?
- Will farmers/industry be able to adapt?
- What is needed to adapt?
- What is the impact of adaptation?



Climate change adaptation: current research & training at UWA

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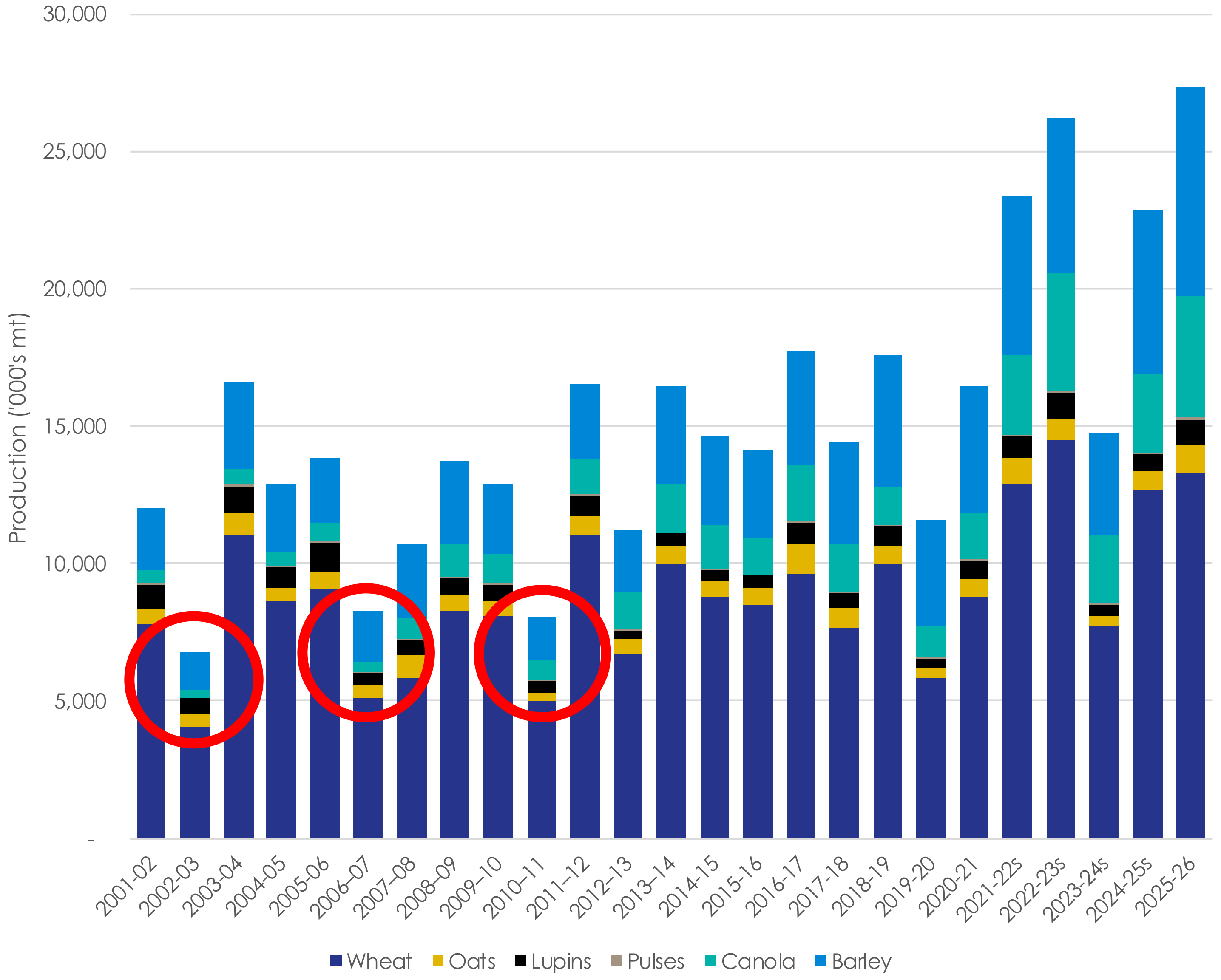
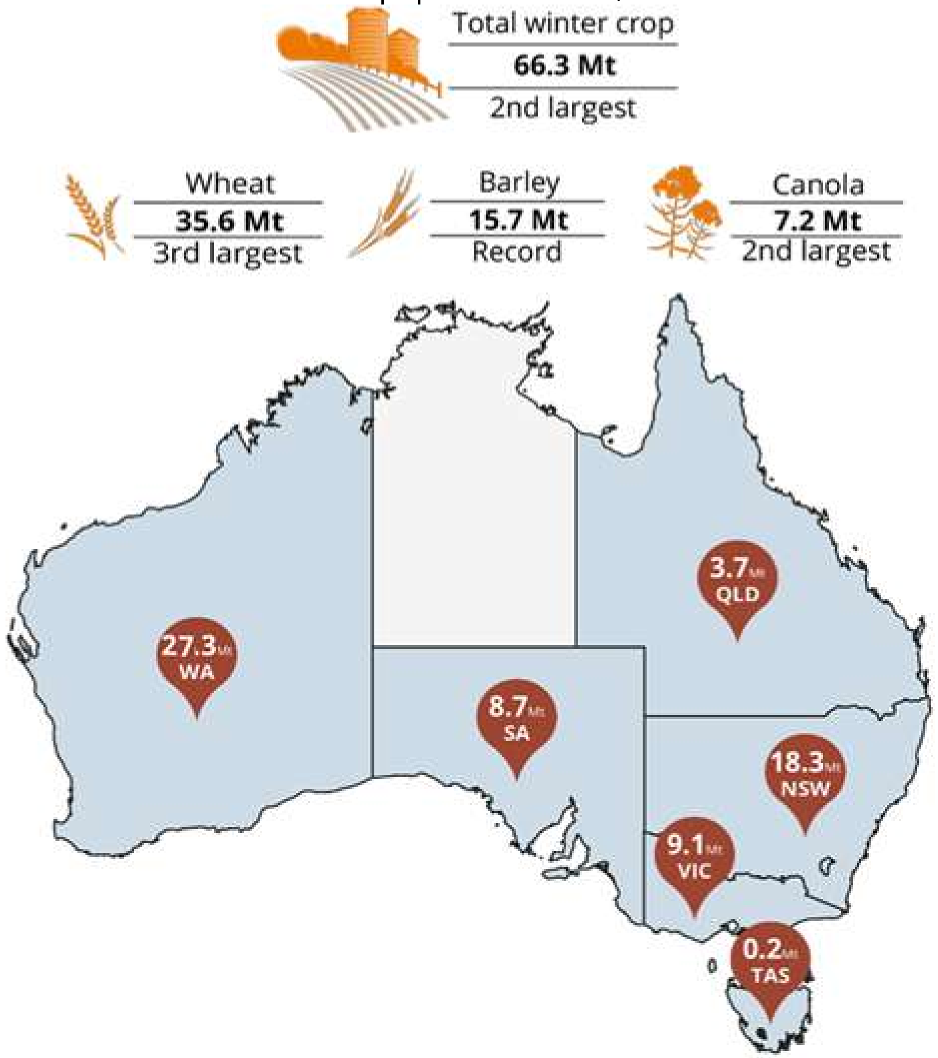
- Climate ready crops and animals (smart genetics and physiology)
- Conservation agriculture
- Green house gases (carbon dioxide, nitrous oxide and methane)
- Soil fertility, biology and carbon sequestration
- Biotechnological tools and biophysical and economic modelling approaches
- UWA Farm Ridgefield, Pingelly
- Partnership with farming community and industry
- Undergraduate and postgraduate programs
- International collaboration

WA Grain production 2001-2026

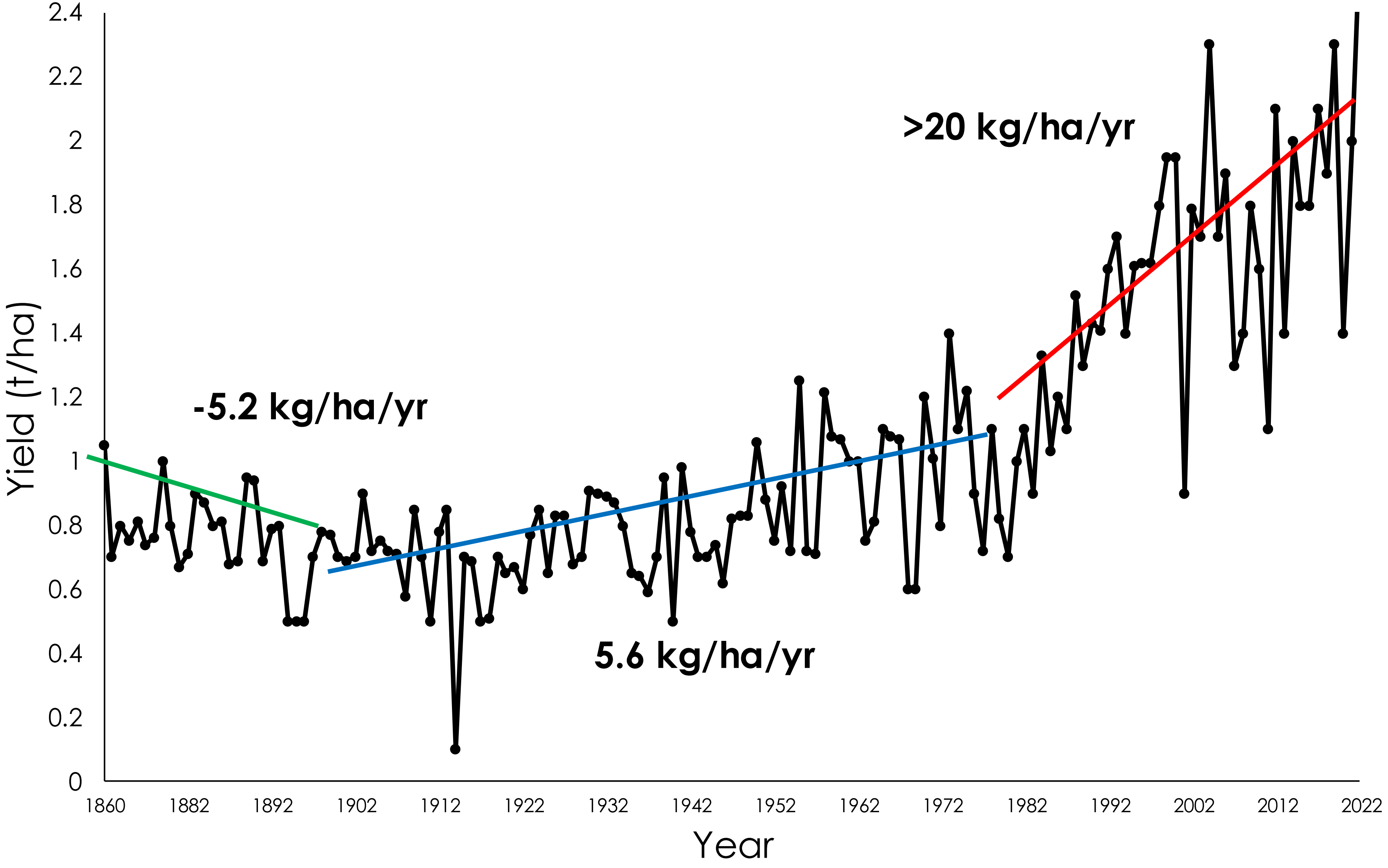


Australian winter crop production, 2025-26

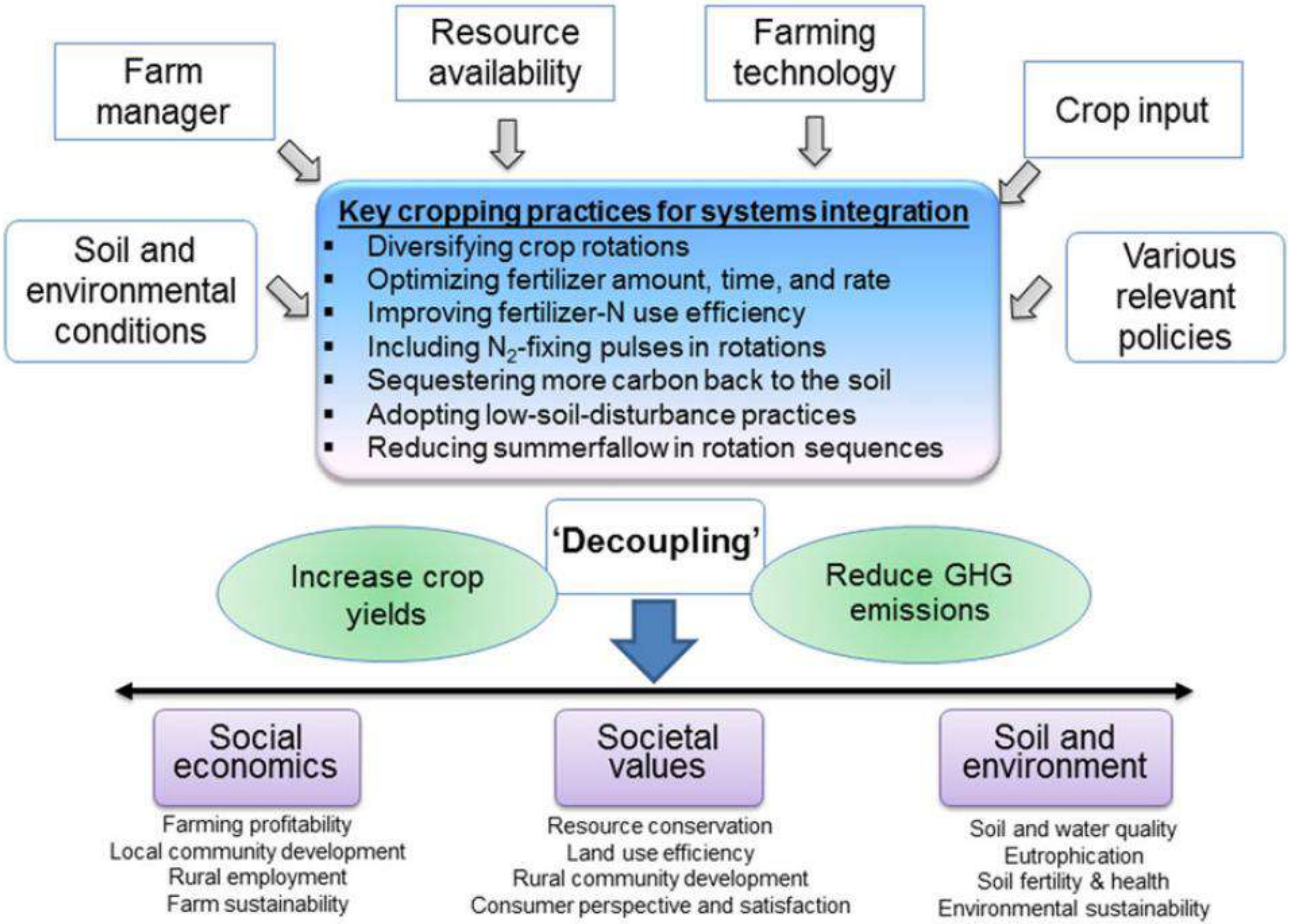


Australian Crop Report Dec 2025

WA wheat Yield



Decoupling agricultural production and GHG emission?



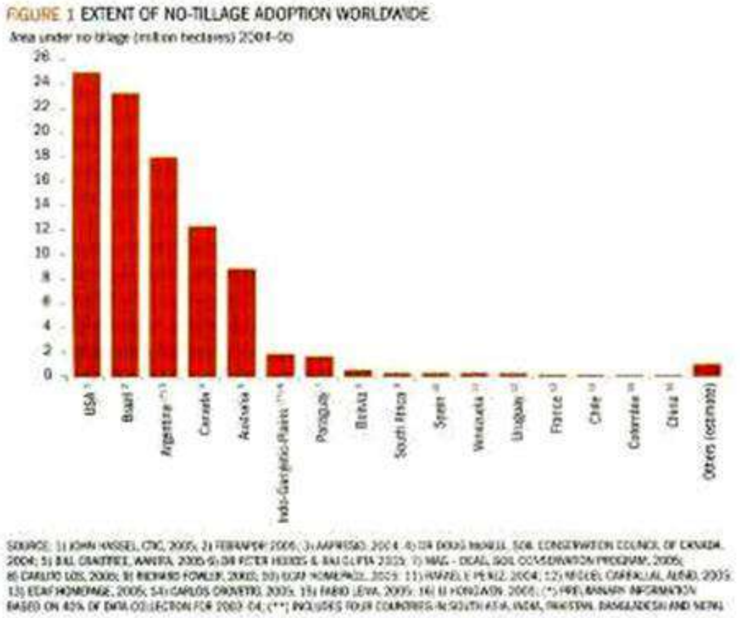
Land Degrad Dev. 2018;29:4348–4361.

Zero tillage – key to conservation cropping

- minimum soil disturbance
- stubble retention
- widely adopted around the world
- mainly in developed countries

Strong benefits

- early sowing
- higher yield potential
- savings - time, machinery, fuel
- better soil structure (OM)
- better soil-water dynamics (porosity)
- better nutrient recycling (NPK)
- improved trafficability
- less pollution
- less erosion
- C sequestration (1%C = 33t/ha)



Conservation Cropping Package

- **Stop ploughing**
- If needed, kill weeds at sowing with glyphosate
- **Plant early**
- **Use ZT seeders** for all crops
- Use good quality seed of best adapted varieties
- **Reduce seed rates**; 50-100kg/ha cereals; 100-150kg/ha pulses
- Sow consistently at optimum depth (4-6cm)
- Use best fertility & weed/disease/pest management
- Include non-cereals in rotation
- Keep stubble if possible - don't burn
- **Graze stubble if needed** - doesn't cancel ZT benefits

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Make sure that every drop of rain goes in for potential use by the crop

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No-Till technology with high levels of stubble retention

Long term no-till and controlled traffic (2006)
Water Use efficiency

= Yield / crop water use (Rainfall + stored – evaporation)
= 2000 kg/ha / (129mm + 81mm stored) – 80mm evaporation
= 15.38 kg/mm/ha

Timescale of no-till

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Initial Phase

- Rebuild aggregates
- Low OM
- Low residue
- Require N - Immob N > Min

0-5 Yrs

Transition Phase

- Increase OM
- Increase crop residue

5-10 Yrs

Consolidation

- High OM
- High crop residue
- Increase moisture
- Less N - Immob < Min

10-20 Yrs

Maintenance

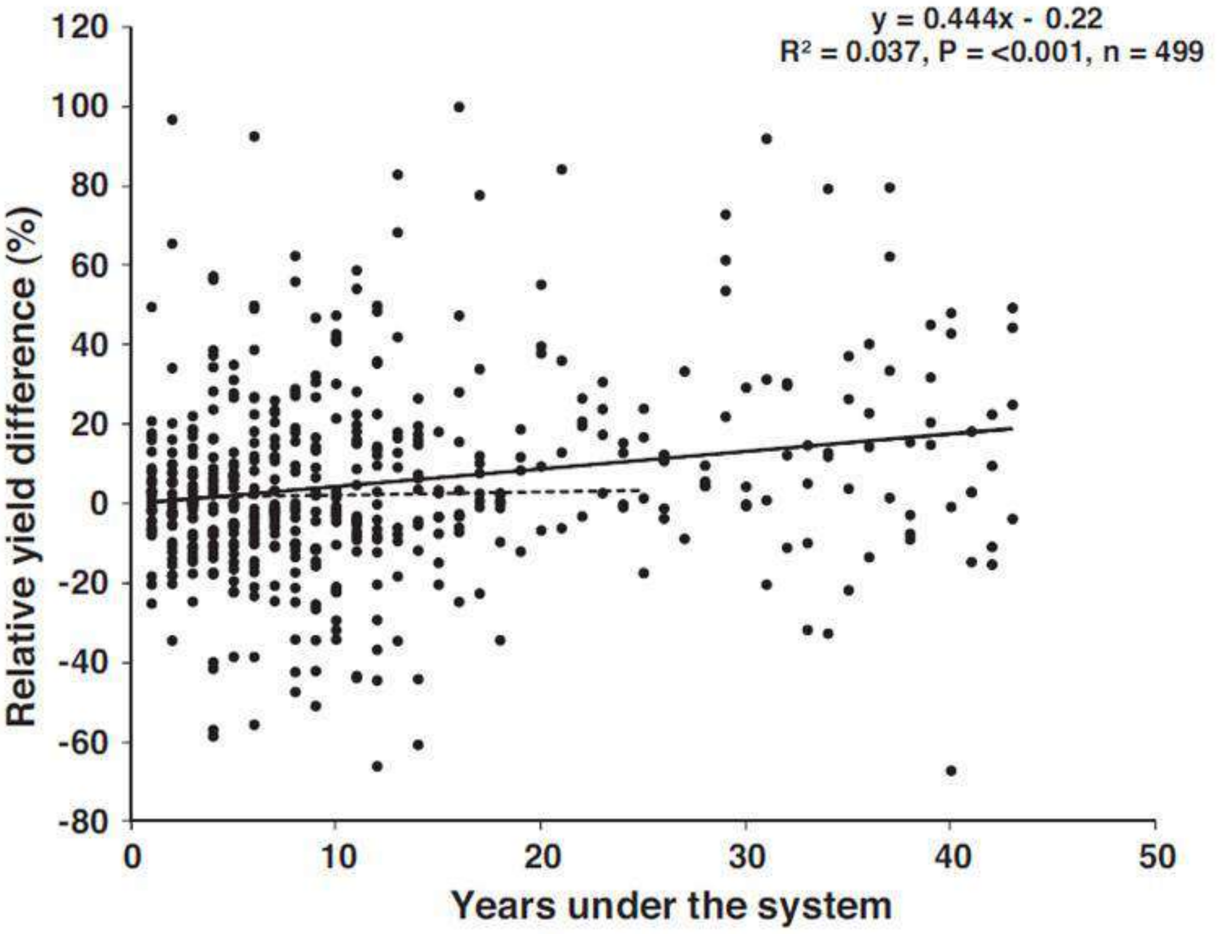
- High OM
- High crop residue
- > moisture
- Nutrient cycling
- Less N - Immob < Min

>20 Yrs

Source: Dr Ken Flower

Benefits of zero tillage increases with time

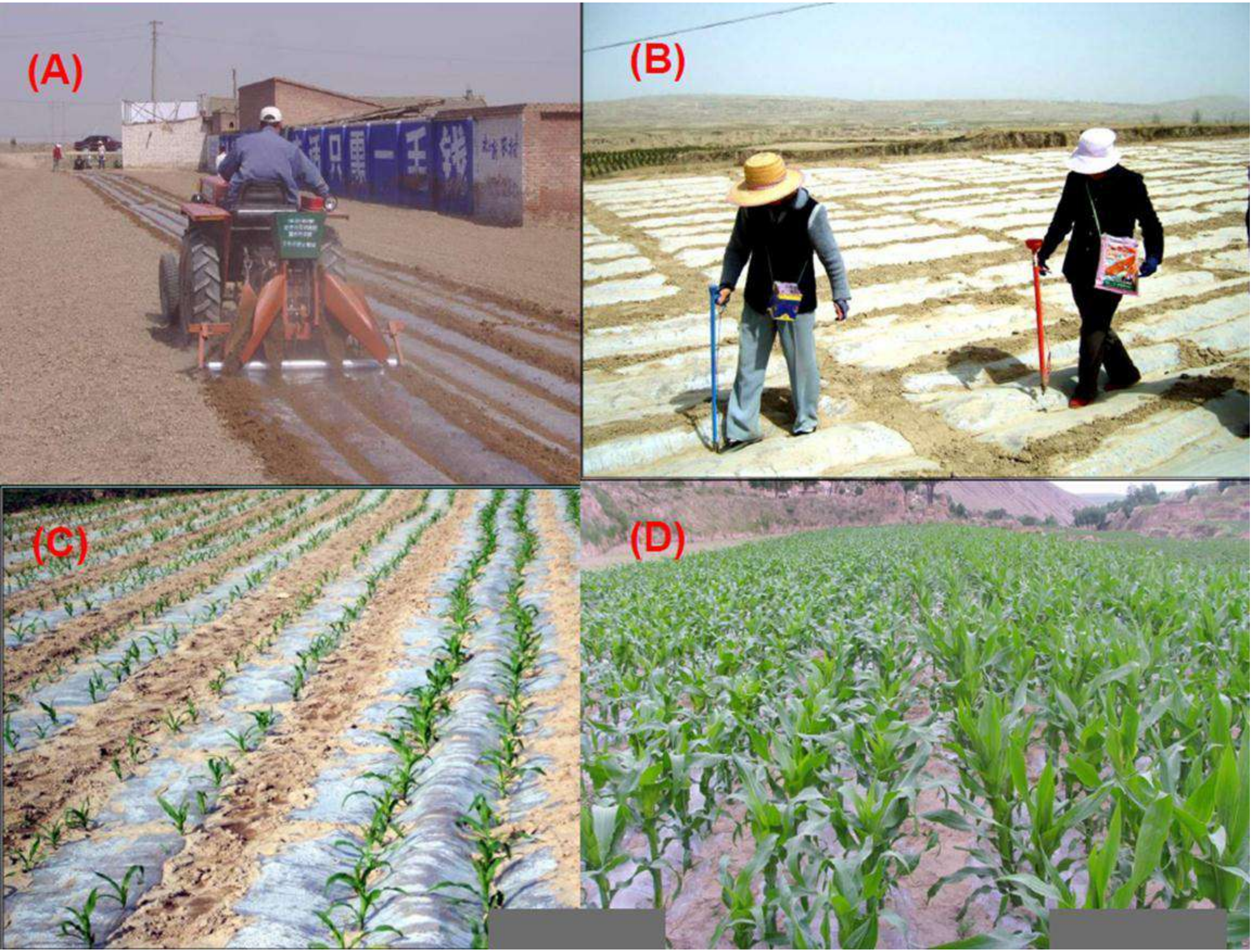
- **Data from 25 long term experiments for number of different crops- Australia, China, Mexico, Brazil, Spain, U.K and USA;**
- **The regression of relative yield difference between zero tillage and convectional tillage showed a slight increase in yield with zero tillage over time.**



Farooq, Flower, Jabran, Wahid & Siddique (2011). Soil & Tillage Research.

Water Saving Options – Plastic Mulch, Gansu Province, China

Gan, Siddique *et al.* (2013). Advances in Agronomy



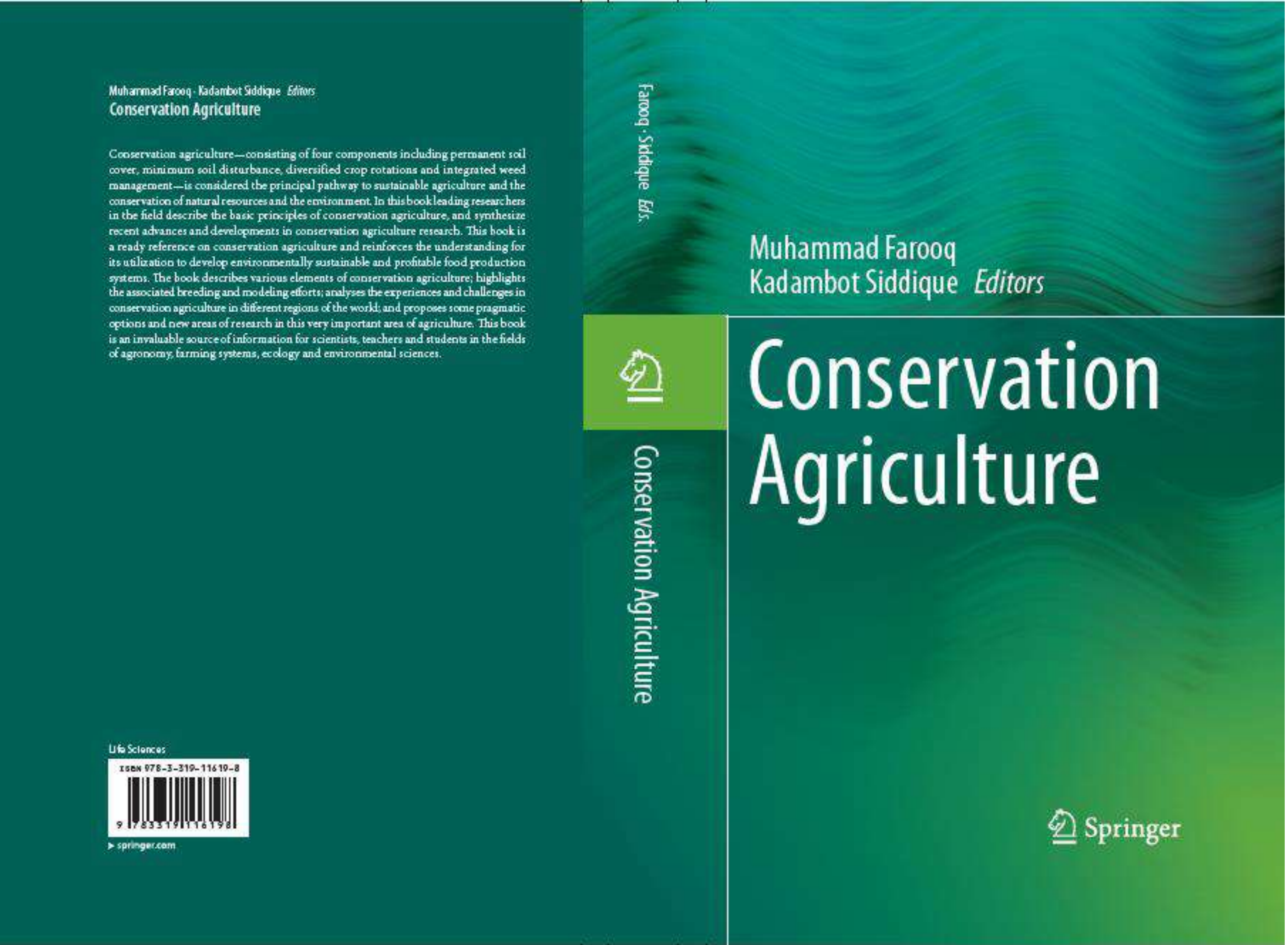
Plastic Mulch-Locally Developed Technology - Ganus Province, China

Chai *et al*. (2014). Advances in Agronomy

Yield: 7000-11000kg·ha-1
WUE: 19-30 kg·ha-1·mm-1

Yield: 2000-3500kg·ha-1
WUE: 7-10 kg·ha-1·mm-1

Source: Fusuo Zhang



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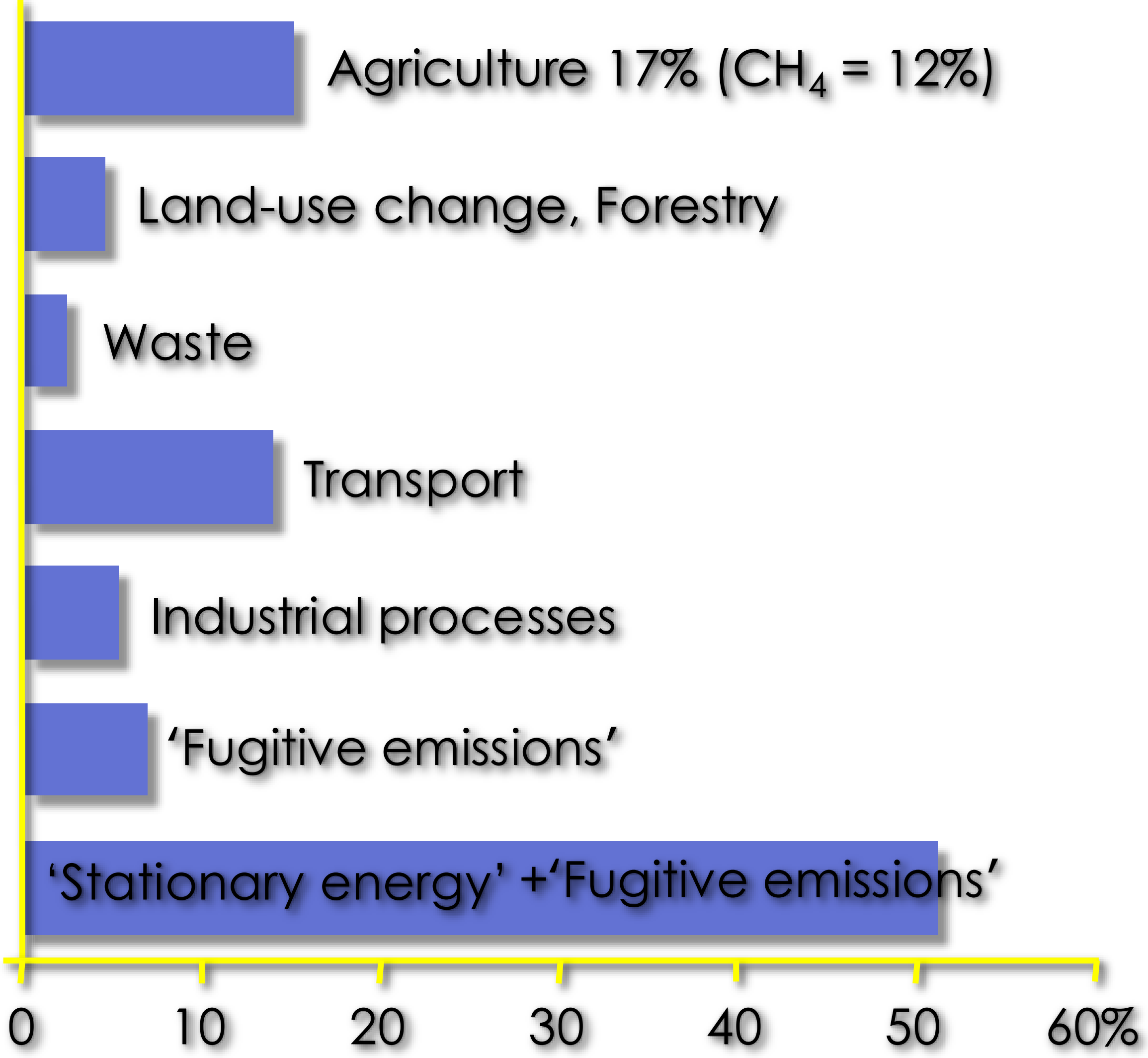
Australia's greenhouse gas emissions

CO_2 equivalent



The Biology of Enteric Methane

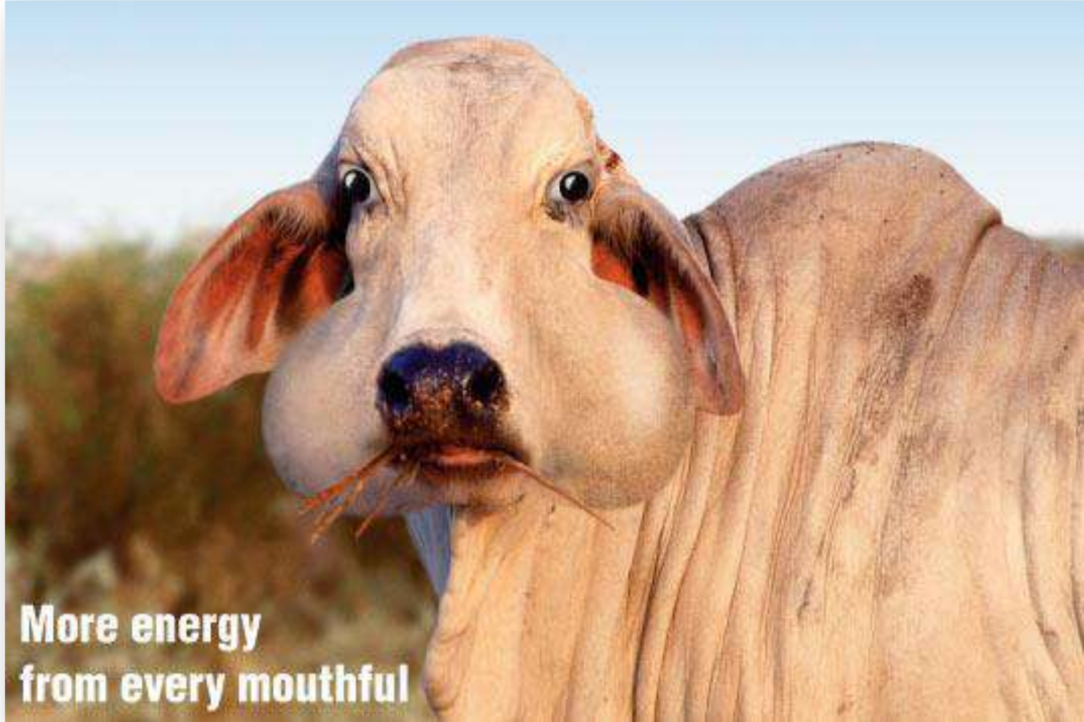
Methane energy: 55 MJ/kg

CH_4 Emission = Energy Loss

- 6-10% of Gross Energy Intake(GEI)
- 3-4 times bigger than Meat or Wool Production
- Largest inefficiency in ruminant production

Prevent CH_4 Emission

= Prevent Energy Loss



Measuring Methane production
From Laboratory to Landscape

In vivo

Animal house chamber

Field scale

Portable accumulation chambers

Australia's CH_4 Mitigation Research

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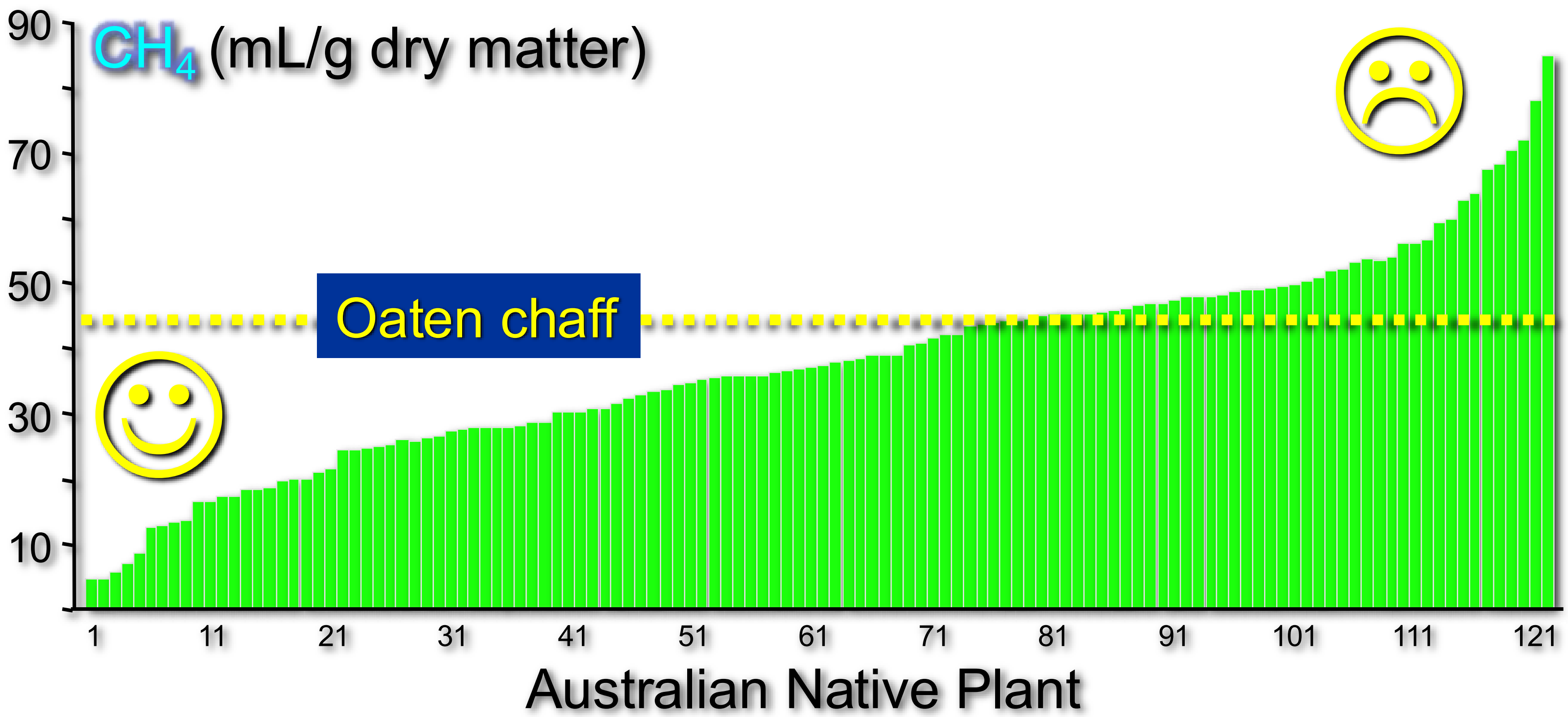
1) Novel Forages



Eremophila glabra

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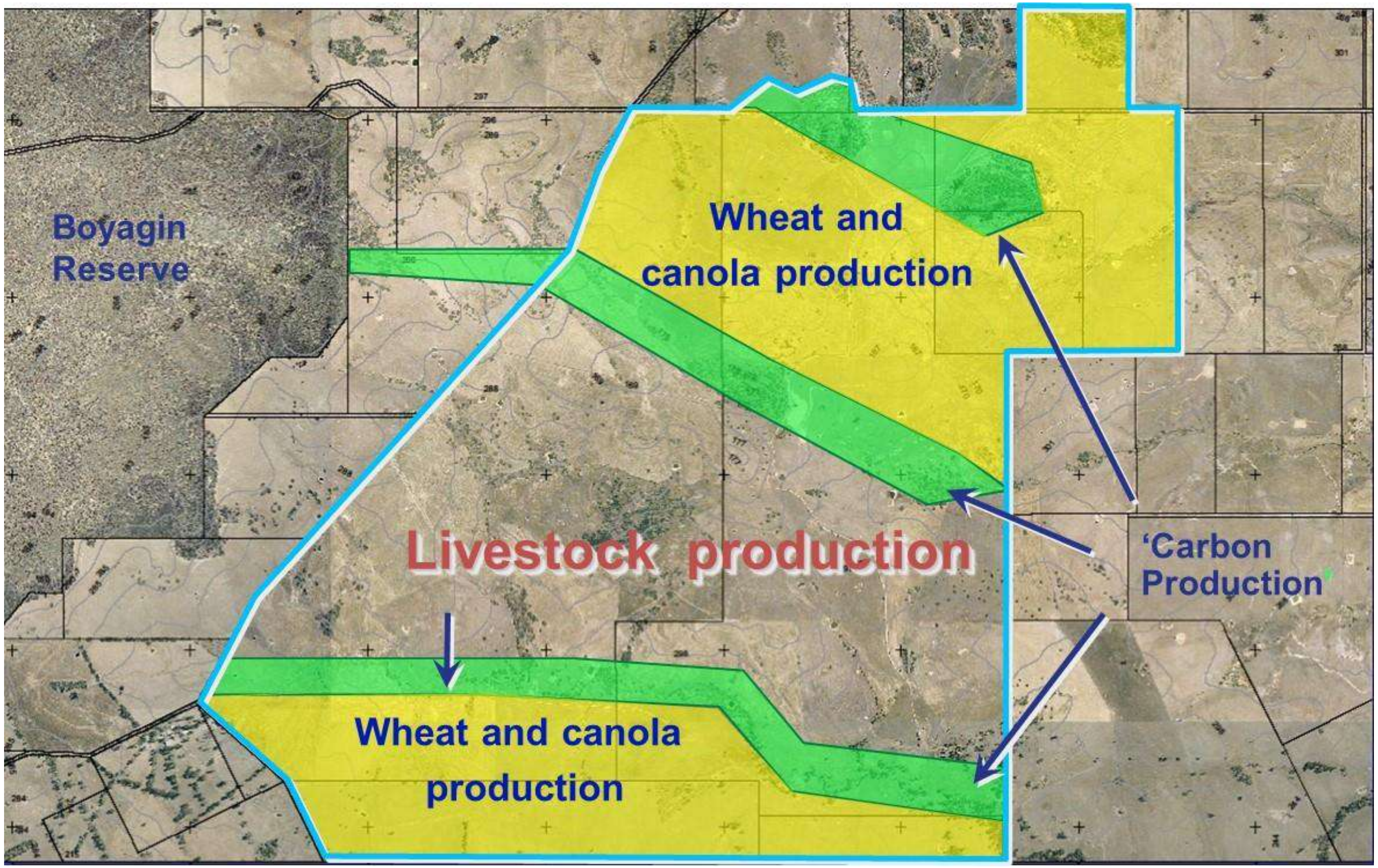
UWA Farm Ridgefield



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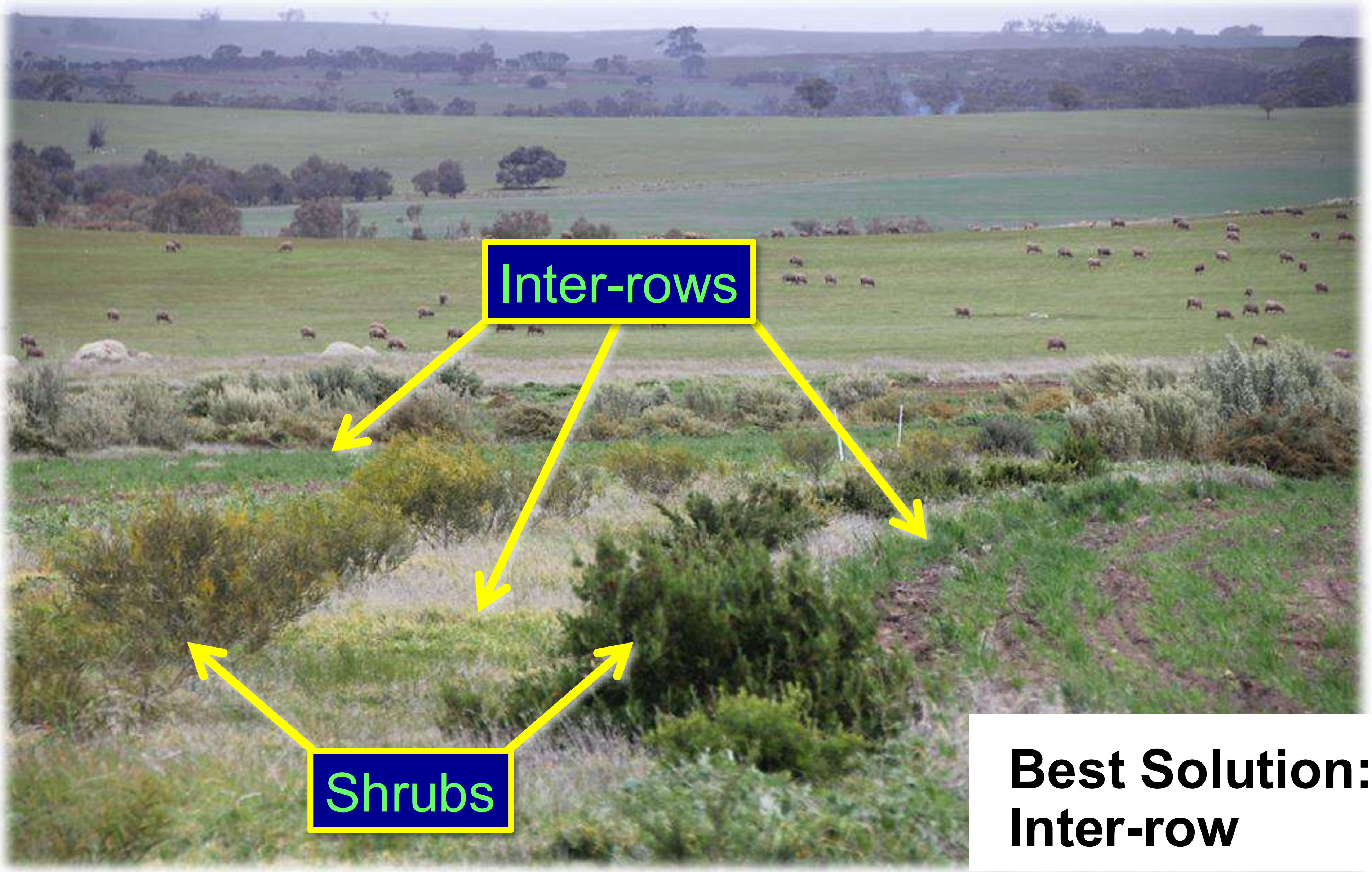


Best Solution: Shrubs + Inter-row

Integrated farming with intercropping increases food production while reducing environmental footprint

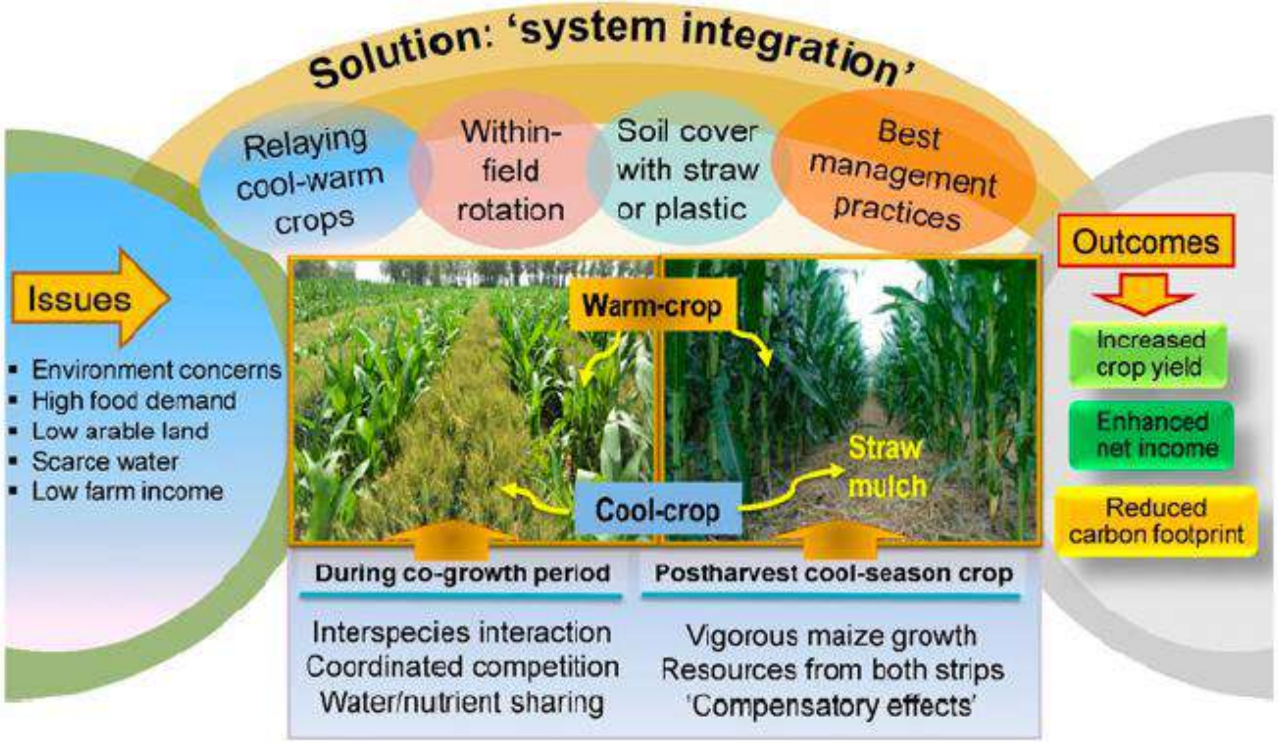
Qiang Chai[a,1], Thomas Nemecek[b], Chang Liang[c], Cai Zhao[a], Aizhong Yu[a], Jeffrey A. Coulter[d], Yifan Wang[a], Falong Hu[a], Li Wang[a,1], Kadambot H. M. Siddique[e], and Yantai Gan[f,1,2]

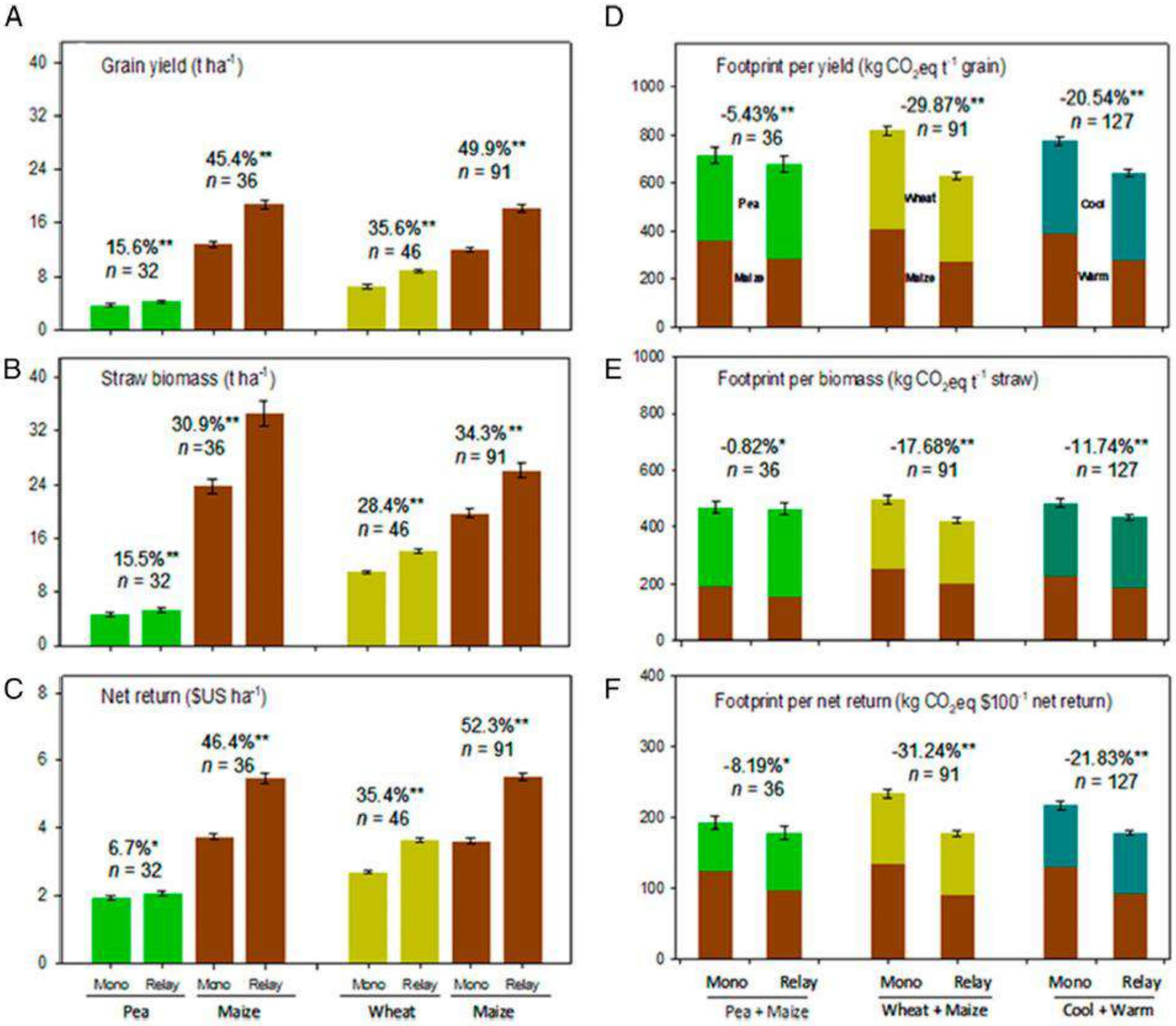
[a]Gansu Provincial Key Laboratory of Aridland Crop Sciences, College of Agronomy, Gansu Agricultural University, Lanzhou, 730070, China; [b]Agroscope, Life Cycle Assessment Research Group, CH-8046 Zurich, Switzerland; [c]Pollutant Inventories and Reporting Division, Environment and Climate Change Canada, Gatineau, QC K1A 0H3, Canada; [d]Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, MN 55108; [e]The University of Western Australia Institute of Agriculture, The University of Western Australia, Perth, WA 6001, Australia; and [f]Agriculture and Agri-Food Canada, Swift Current Research and Development Centre, Swift Current, SK S9H 3X2, Canada

Edited by Charles Godfray, University of Oxford, Oxford, United Kingdom, and accepted by Editorial Board Member Ruth DeFries June 10, 2021 (received for review April 9, 2021)

Food security has been a significant issue for the livelihood of smallholder family farms in highly populated regions and countries. Industrialized farming in more developed countries has increased global food supply to meet the demand, but the excessive use of synthetic fertilizers and pesticides has negative environmental impacts. Finding sustainable ways to grow more food with a smaller environmental footprint is critical. We developed an integrated cropping system that incorporates four key components: 1) intensified cropping through relay planting or intercropping, 2) within-field strip rotation, 3) soil mulching with available means, such as crop straw, and 4) no-till or reduced tillage. Sixteen field experiments, conducted with a wide range of crop inputs over 12 consecutive years (2006 to 2017), showed that the integrated system with intercropping generates significant synergies—increasing annual crop yields by 15.6 to 49.9% and farm net returns by 39.2% and decreasing the environmental footprint by 17.3%—when compared with traditional monoculture cropping. We conclude that smallholder farmers can achieve the dual goals of growing more food and lowering the environmental footprint by adopting integrated farming systems.

PNAS 2021 Vol. 118 No. 38 e2106382118





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Crop productivity and carbon footprints of monoculture versus relay-planting systems. **(A) Grain yield**, (B) straw biomass, and (C) net returns for monoculture pea, monoculture maize, and monoculture wheat, relative to pea + maize and wheat + maize relay planting. **The carbon footprint was determined per unit of (D) grain yield**, (E) straw biomass, and (F) net return. Percentages in each pair of bars denote mean differences between monoculture and relay planting, n represents the number of paired comparisons, and * and ** denote that the mean difference between pairs is significant at $P \leq 0.05$ and $P \leq 0.01$, respectively.

PNAS 2021 Vol. 118 No. 38 e2106382118

Pulse crops in cropping systems

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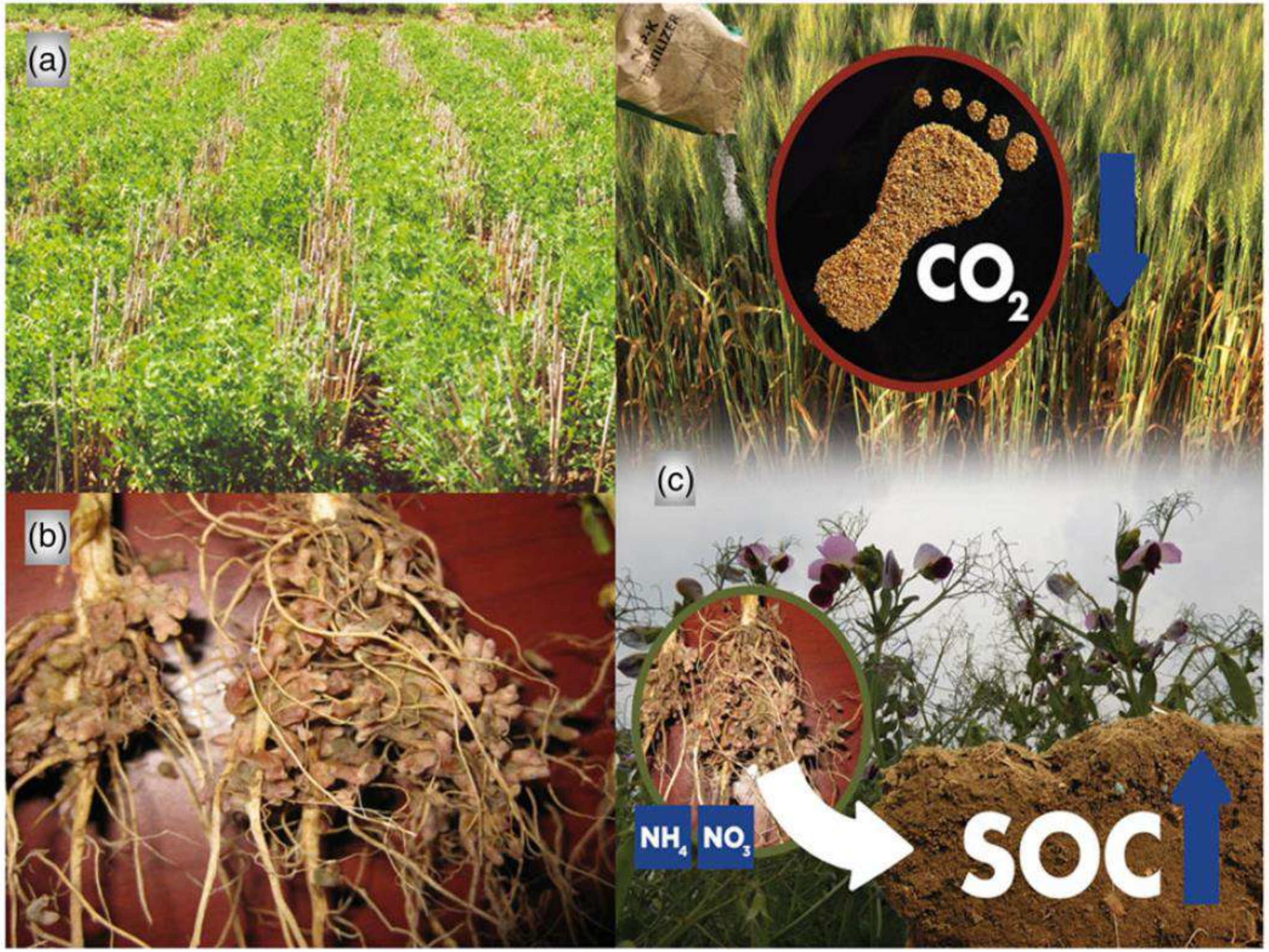
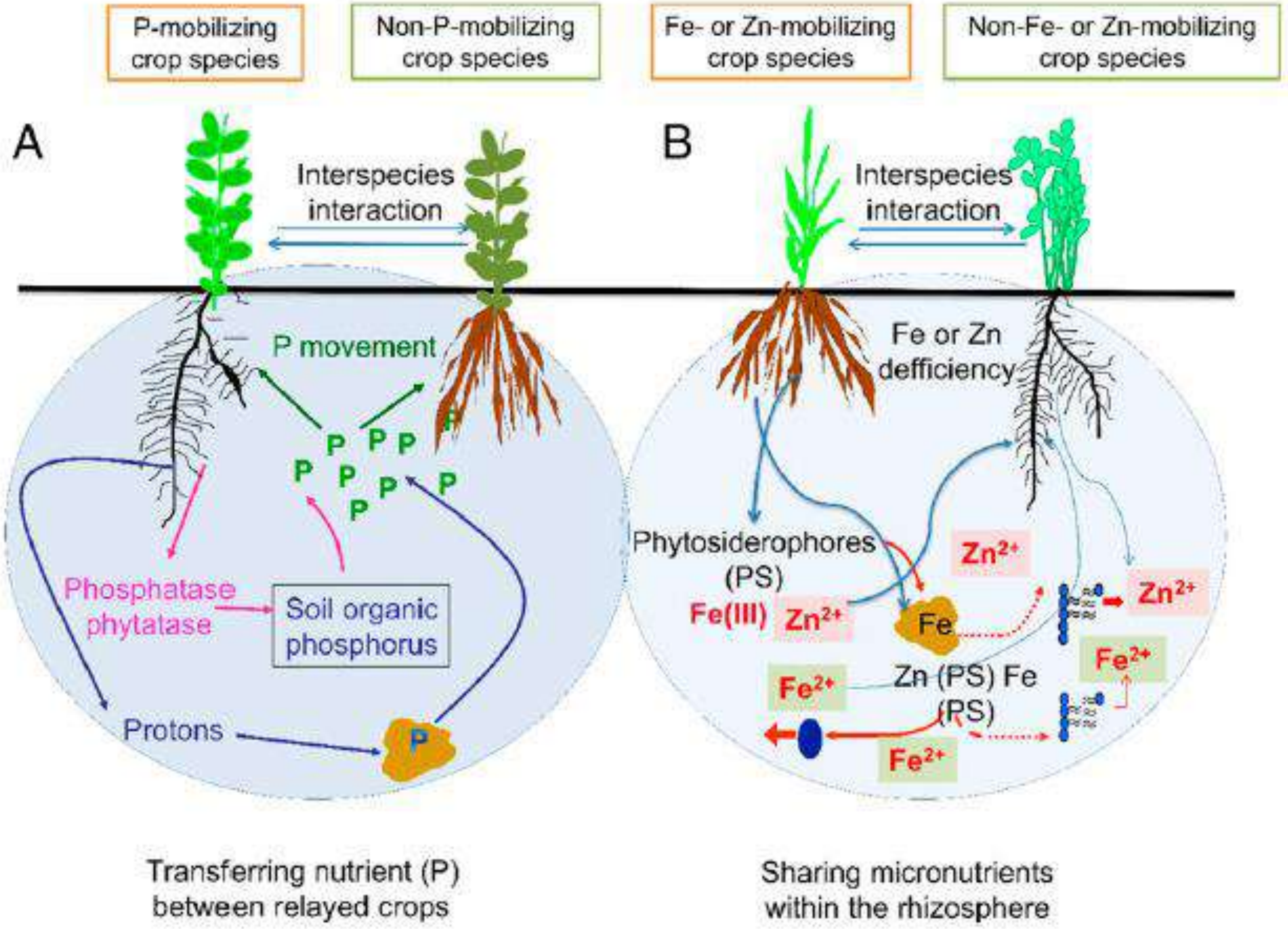


The beneficial role of pulse crops in cropping systems. Pulse crops can be typically no-till planted **(a) in rotation with cereals, with (b) numerous nodules on plant roots that fix N2 from the atmosphere, leading to significant benefits to the cropping systems, such as (c) reducing the use of inorganic N fertilizer, increasing soil organic carbon, and decreasing the carbon footprint of agroecosystems**

Land Degrad Dev. 2018;29:4348-4361.



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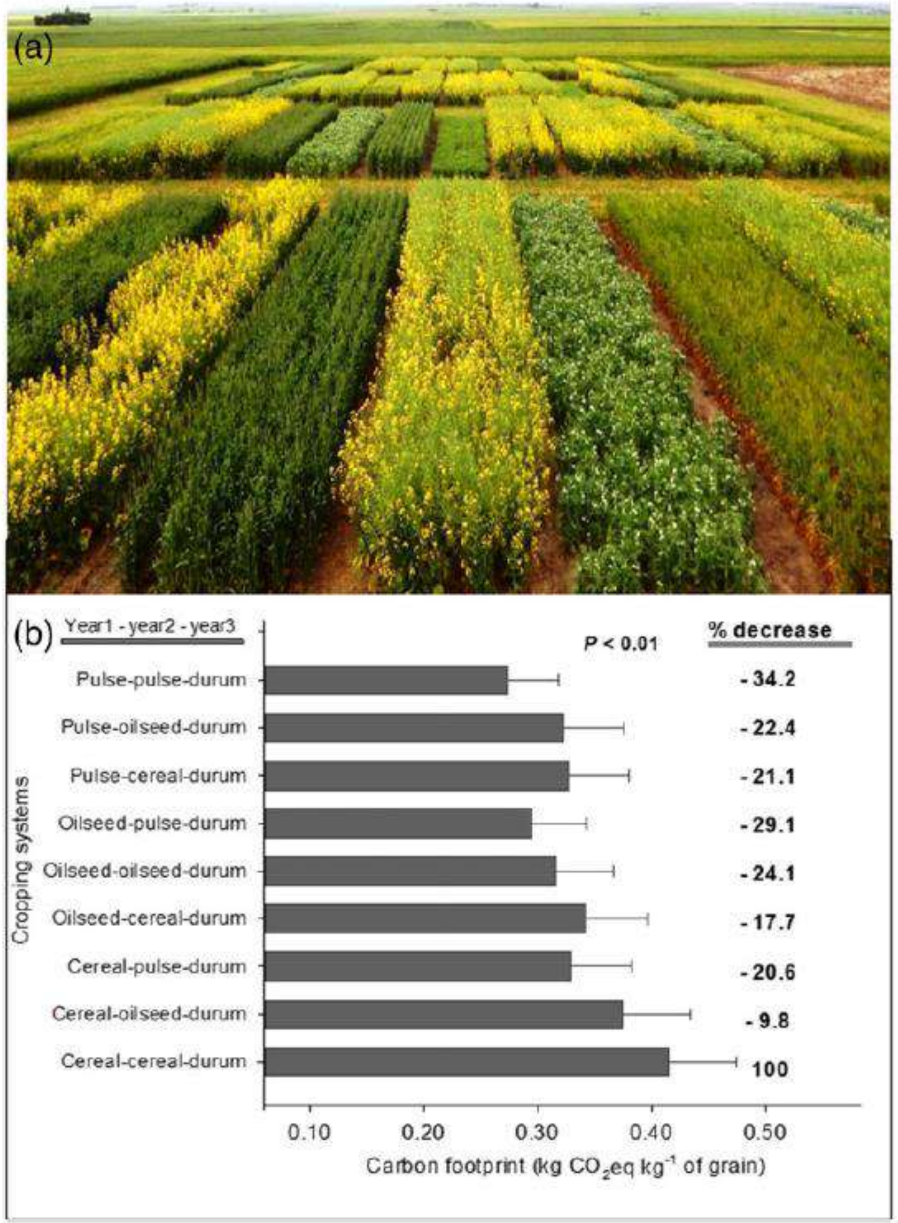
Potential nutrient mobilization and sharing within the rhizospheres of relayed crops.

(A) **P as an example to illustrate possible interspecific facilitation f**or nutrient sharing between nutrient-mobilizing and non-nutrient-mobilizing crop species in relay systems, and

(B) **two essential micronutrients—iron (Fe) and zinc (Zn)—as examples to illustrate possible nutrient enhancement through belowground interspecies interactions** when two crops with contrasting growth habits are relay planted in field strips (adapted from ref. 21 with modifications).

PNAS 2021 Vol. 118 No. 38 e2106382118

Diversifying cropping systems



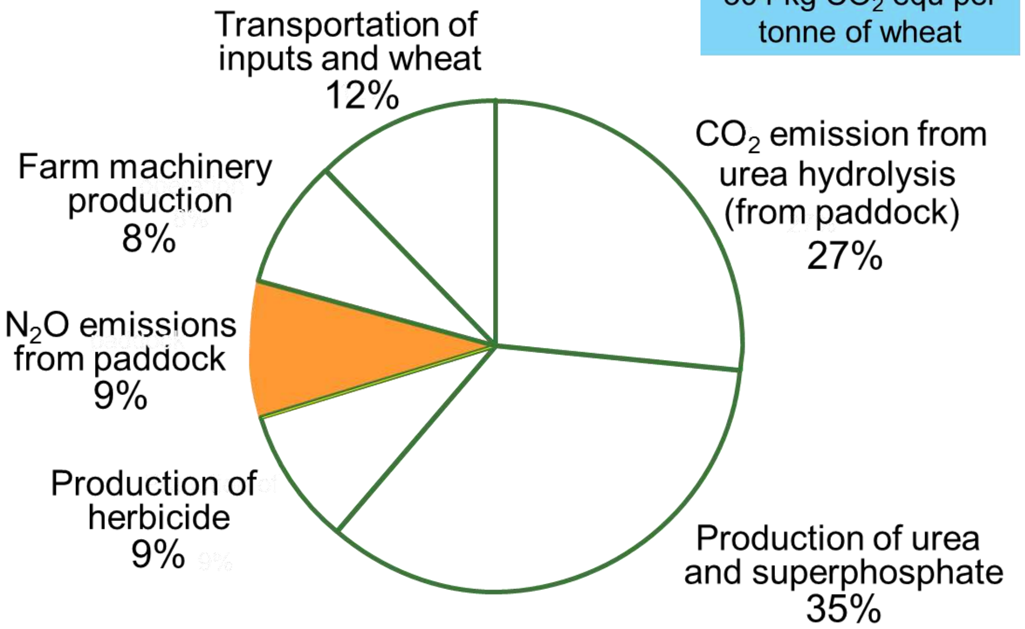
Diversifying cropping systems (a) are used to replace conventional cereal-based monoculture systems, leading to (b) reduced carbon footprint of durum wheat in the Northern Great Plains of North America

Land Degrad Dev. 2018;**29**:4348–4361.

Greenhouse gas emissions from WA cropping systems

- Quantified Carbon footprint of grains production in WA
- Carbon footprint of grains production is influenced by CO_2 emissions from the production and use of N fertilisers, as well as soil nitrous oxide emissions
- Because of efficient N fertiliser use and low nitrous oxide emissions from our cropping system, greenhouse gases emissions from WA is low

304 kg CO_2 equ per tonne of wheat



Source: Biswas *et. al.* 2008. *Water and Environment Journal* 22: 206-216.

Innovations in Dryland Agriculture

- Written by experts in the fieldPresents innovations in dryland agriculture researchFocuses on sustainable and profitable food production systems in drylands

In this book leading scientists in the field describe the basic principles of dryland agriculture, and synthesize recent experiences and innovations in dryland agriculture research and development. It is a ready reference on the subject and reinforces the understanding for its utilization to develop environmentally sustainable and profitable food production systems. Various elements of dryland agriculture are described, highlighting associated breeding and modelling efforts, analysing the experiences and challenges of dryland agriculture in different regions, and it proposes some practical innovations and new areas of research in this critical area of agriculture. This book is an invaluable source of information for scientists, teachers and students in the fields of agronomy, ecology, environmental sciences, range management, land and water management and sustainable livestock grazing systems.

Printed book

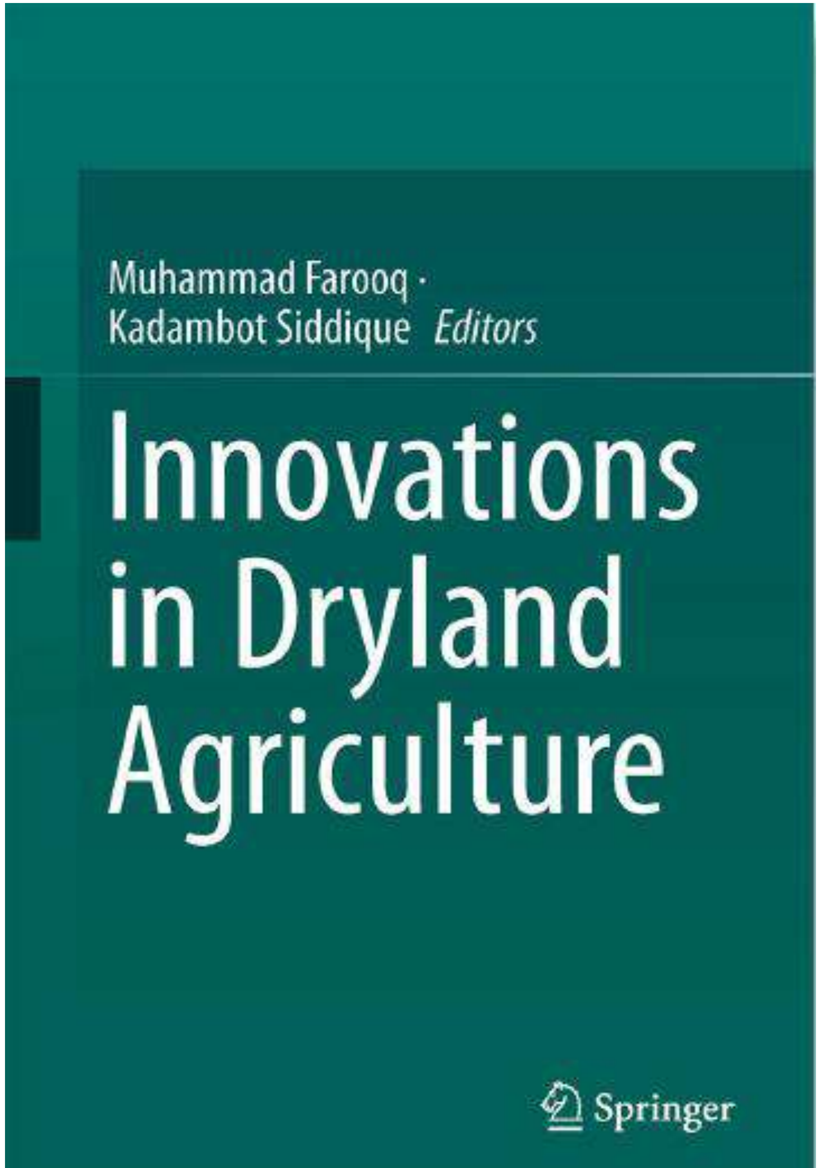
Hardcover

- 214,00 € | £159.50 | $249.00
- *228,98 € (D) | 235,40 € (A) | CHF 235.00

eBook

Available from your library or

- springer.com/shop



Case study

APN Science Bulletin

2023, Volume 13, Issue 1, 241–262, e-ISSN 2522-7971

Climate-smart agriculture strategies for South Asia to address the challenges of climate change: Identification of climate-resilient agriculture practices for India, Bangladesh, and Afghanistan

Nutan Kaushik[a*], **Kadambot H. M. Siddique**[a,b], **Md. Saleh Ahmed**[c], **Sayed Samiullah Hakimi**[d]

[a]Amity Food and Agriculture Foundation, Amity University Uttar Pradesh, Noida 201313, Uttar Pradesh, India
[b]The UWA Institute of Agriculture, The University of Western Australia, 35 Stirling Highway, Perth WA 6009, Australia
[c]Kernel Foundation, Progress Kohinoor, Apartment No. B-2, House 18, Road 10, Gulshan-1, Dhaka 1212, Bangladesh
[d]Horticulture Department, Agriculture Faculty, Kabul University, Kabul, Afghanistan

* *Corresponding authors. Emails: nkaushik5@amity.edu, kaushikn2008@gmail.com.*

ABSTRACT

In South Asia, agriculture is pivotal for food and nutritional security and the livelihood of more than 50% of the population. Food production and nutritional security pressures intensify as urbanisation decreases the agricultural land area amid population growth. Climate change complicates this scenario by introducing elevated temperatures, extreme climatic events, surging sea levels, and increased soil salinity. Identifying climate-resilient

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Conservation Agriculture

FIGURE 2. Conservation agriculture in Kabul, Afghanistan.

Intercropping

FIGURE 3. Intercropping demonstration.

Floating bed cultivation- Bangladesh

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FIGURE 6. Floating bed cultivation.

Relay cropping

FIGURE 7. Relay cropping.

Protected cultivation

FIGURE 8. Protected cultivation.

Hitech Nursery

FIGURE 9. HITECH Nursery.

Low raised poly tunnel

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FIGURE 10. Low raised poly tunnel.

Zero energy cool chamber

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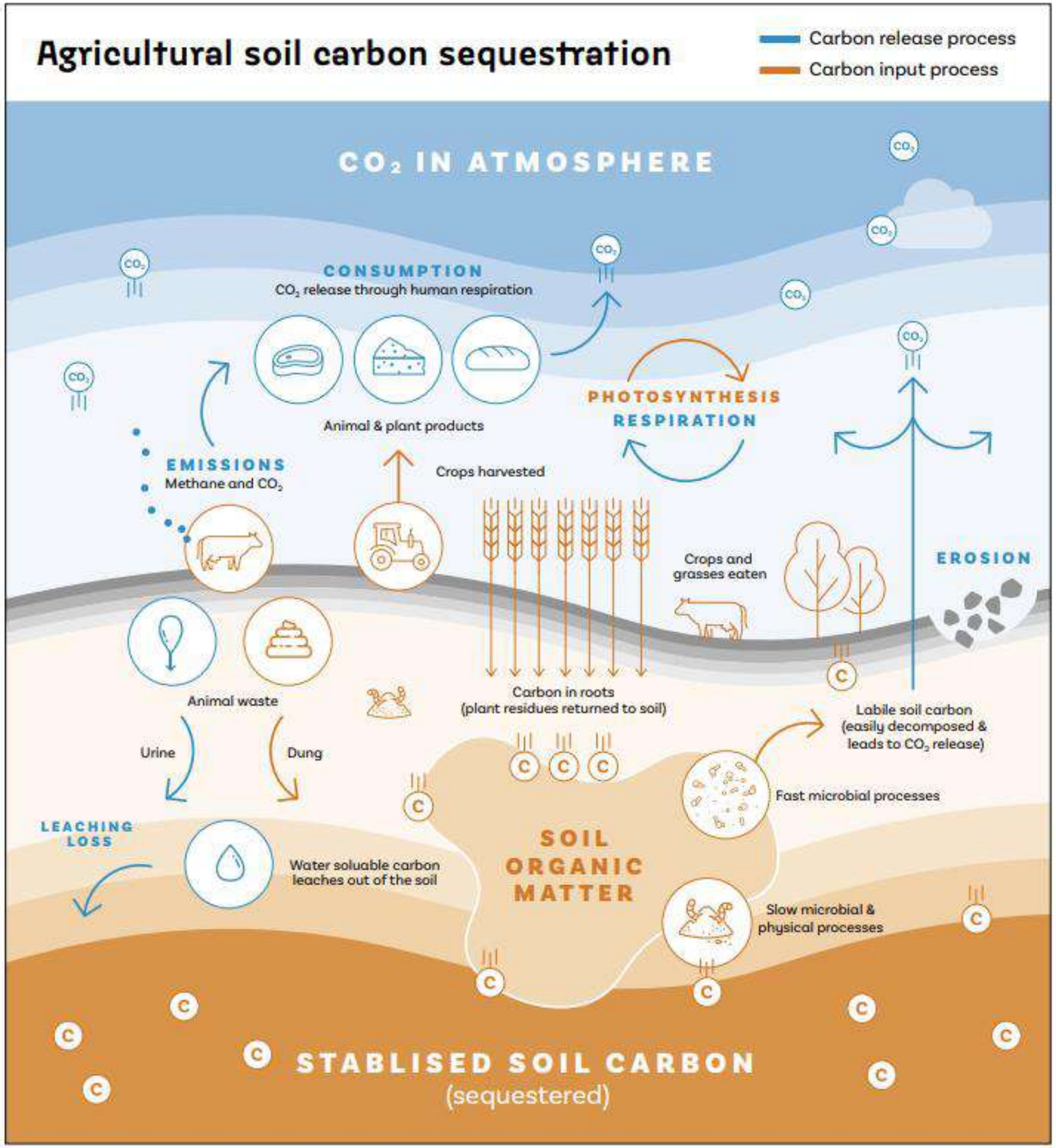
FIGURE 12. Zero energy cool chamber (ZECC), constructed by Amity University at Kabul University.

Zero energy cool chamber

FIGURE 13. Turning colour tomatoes can be kept for 29 days in ZECC, Kabul University.



Source: ATSE Explainer Nov 2021

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Soil organic carbon improvement for mitigating crop yield losses under global warming

Qinsi He[a], Linchao Li[b,*], Yu Shi[c], Puyu Feng[d], Ke Liu[e], Shengwei Zhang[a,f,g,**], De Li Liu[h,i], Zikui Wang[j], Matthew Tom Harrison[e], Sien Li[k], Qiang Yu[l], Kadambot H.M. Siddique[m]

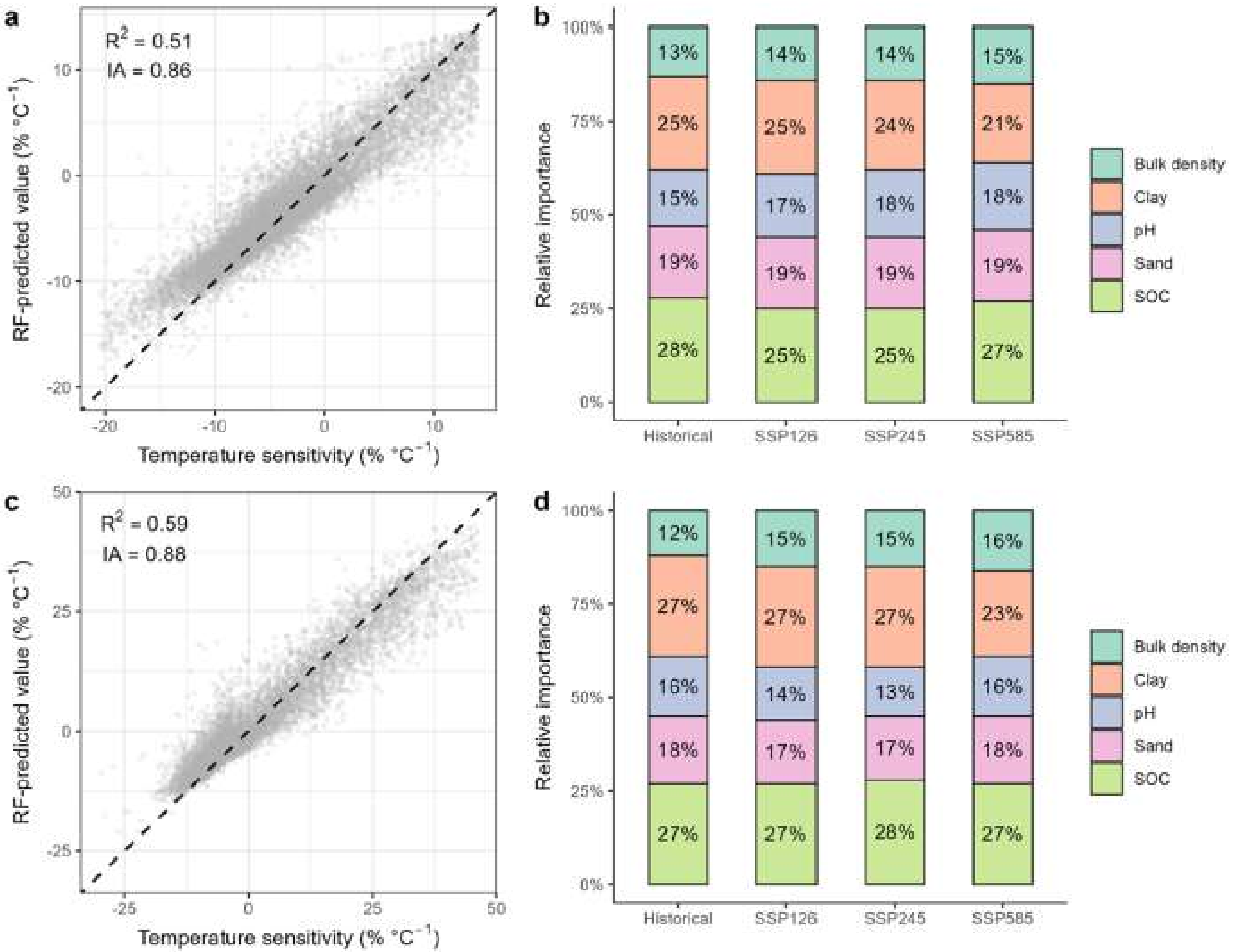
[a] College of Water Conservancy and Civil Engineering, Inner Mongolia Agricultural University, Hohhot 010018, China
[b] College of Agronomy, Inner Mongolia Agricultural University, Hohhot 010019, China
[c] Institute of Carbon Neutrality, Sino-French Institute for Earth System Science, College of Urban and Environmental Sciences, Peking University, Beijing 100871, China
[d] College of Land Science and Technology, China Agricultural University, Beijing 100193, China
[e] Tasmanian Institute of Agriculture, University of Tasmania, Newnham Drive, Launceston, Tasmania 7248, Australia
[f] Inner Mongolia Key Laboratory of Ecohydrology and High Efficient Utilization of Water Resources, Hohhot 010018, China
[g] Autonomous Region Collaborative Innovation Center for Integrated Management of Water Resources and Water Environment in the Inner Mongolia Reaches of the Yellow River, Hohhot 010018, China
[h] NSW Department of Primary Industries, Wagga Agricultural Institute, Wagga, NSW 2650, Australia
[i] Climate Change Research Centre, University of New South Wales, Sydney, NSW 2052, Australia
[j] State Key Laboratory of Herbage Improvement and Grassland Agro-Ecosystems, College of Pastoral Agriculture Science and Technology, Lanzhou University, Lanzhou 730020, China
[k] Center for Agricultural Water Research in China, China Agricultural University, Beijing 100083, China
[l] State Key Laboratory of Soil Erosion and Dryland Farming on the Loess Plateau, Northwest A&F University, Yangling 712100, China
[m] The UWA Institute of Agriculture, The University of Western Australia, Perth, WA 6001, Australia

ARTICLE INFO

Keywords:
Soil properties
Climate change
Yield temperature sensitivity
Soil management
Climate resilience

ABSTRACT

Rising temperatures pose a significant threat to crop production worldwide. While many studies have examined the effects of warming on crop yields, the role of soils in crop-climate interactions is often overlooked. This study investigates how soil properties influence crop yield responses to increased growing season temperatures, using an ensemble of nine global gridded crop models and 37 CMIP6 climate models under three shared socio-economic pathway scenarios. Our findings show that, during 1980–2010, a 1°C increase in temperature resulted in yield changes of −2.3 % for maize and + 3.0 % for soybean. However, under future climate scenarios of 2050–2080, yields are projected to decline by −6.6 % to −7.5 % for maize and −8.9 % to −10.7 % for soybean. Soil properties account for 51 % and 59 % of the spatial variations in temperature sensitivity for global maize and soybean yields, respectively, with soil organic carbon (SOC) emerging as the most influential factor. Improving SOC through farming and soil conservation practices is expected to reduce warming-induced yield losses by 0.5–1.1 % $°C^{-1}$ for maize and 1.3–2.5 % $°C^{-1}$ for soybean, particularly in dryland areas. These benefits diminish under more extreme warming scenarios (i.e., SSP585 vs. SSP126), but can be amplified by adopting new crop varieties with fixed growing seasons. Our findings highlight the buffering effects of SOC on crop responses to warming, suggesting a promising soil-based solution for building resilience in global food production under climate change.

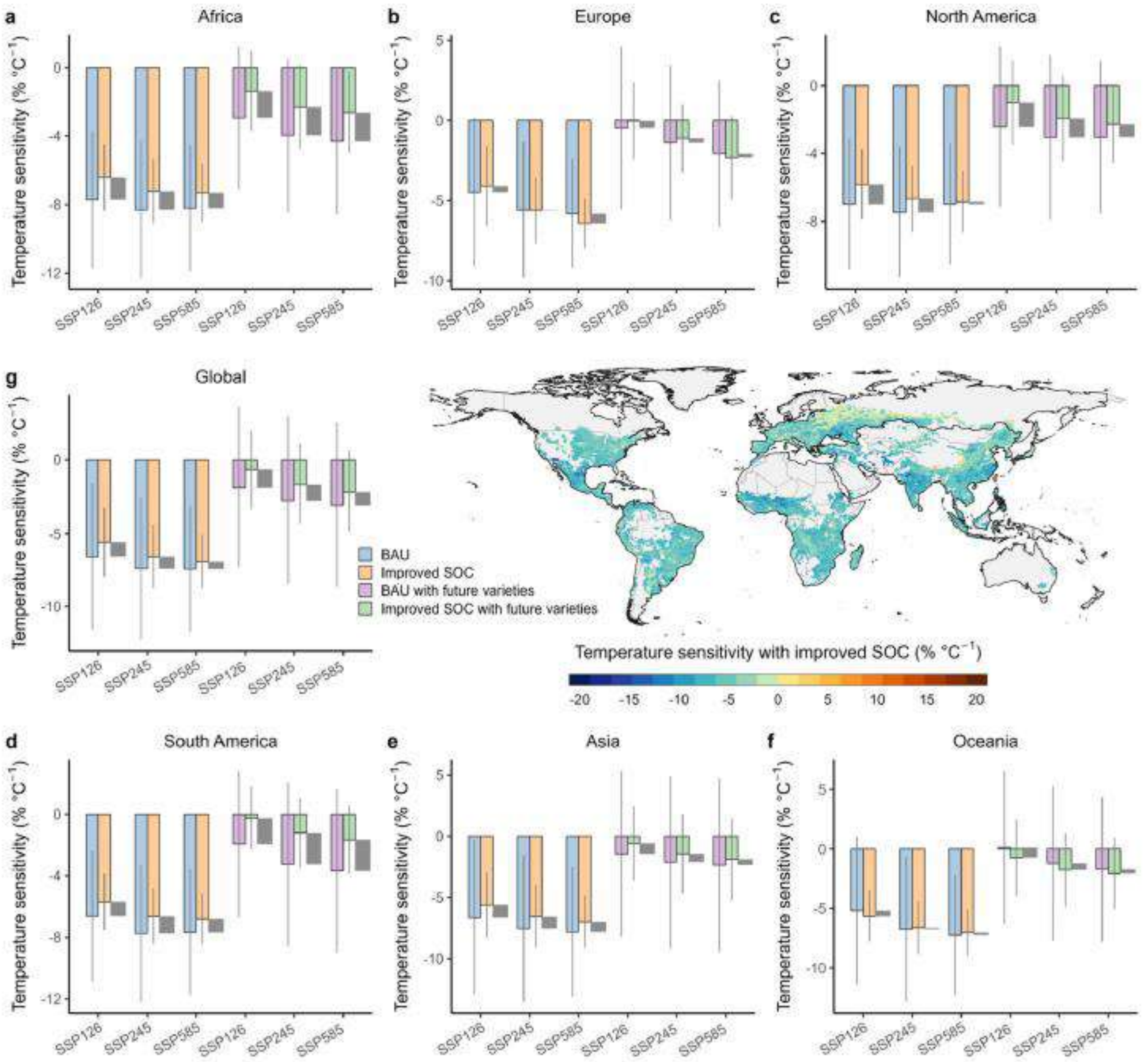


Comparison of temperature sensitivity and random forest (RF) model predictions across global grids:

Maize (a) and soybean (c) during the historical period (1980–2010),

Relative importance of soil properties based on model outputs (b) for maize and (d) for soybean).

The dashed line represents the 1:1 ratio line.



Improved SOC-induced temperature sensitivity changes for maize.

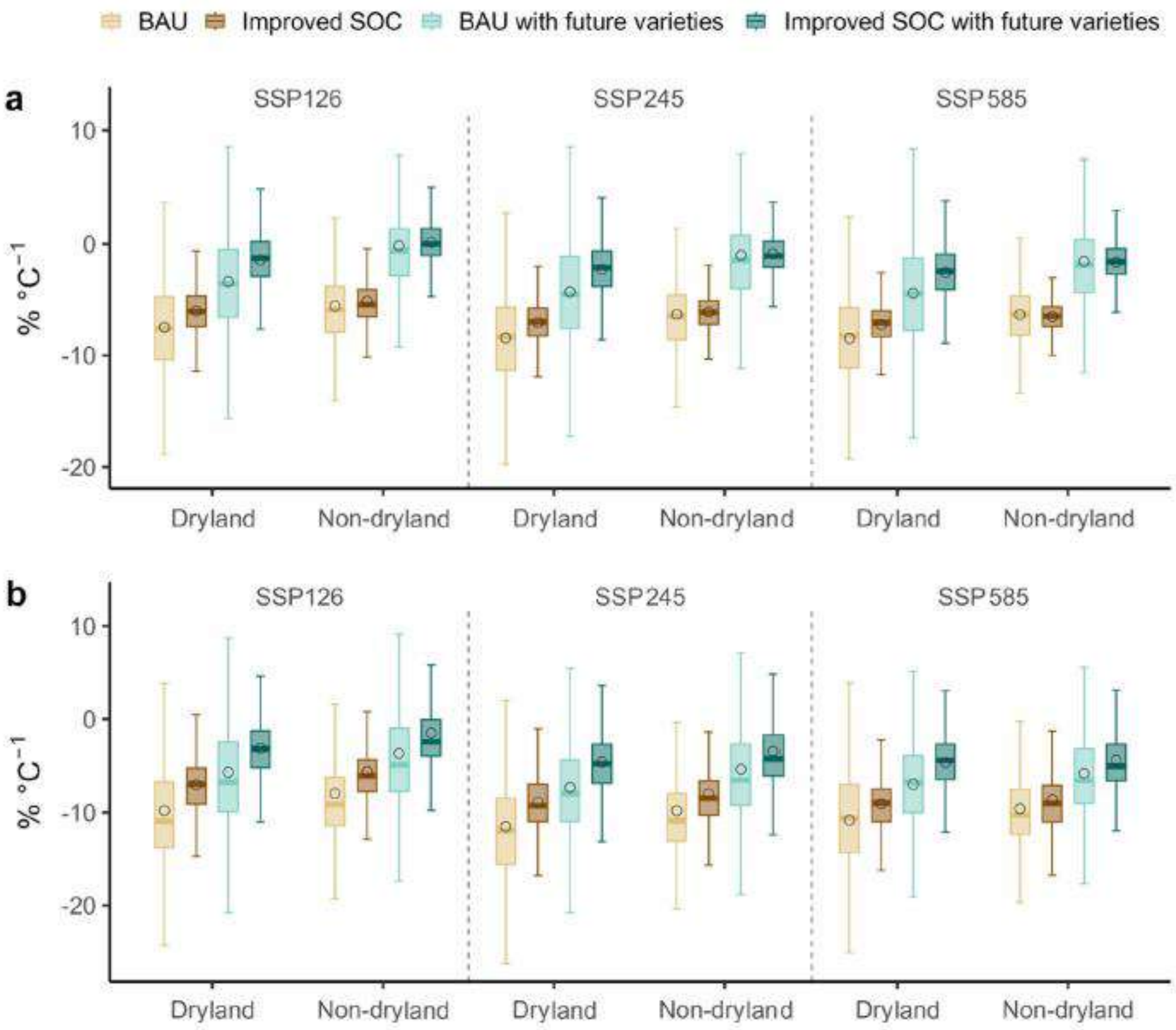
The central map shows temperature sensitivity with improved SOC during 2050–2080 under SSP126.

Each bar chart shows the mean values of temperature sensitivity under different scenarios globally and across six continents:

Africa (**a**), Europe (**b**), North America (**c**), South America (**d**), Asia (**e**), and Oceania (**f**) and globally (**g**).

Gray bars show the changes induced by improved SOC under each scenario.

BAU means scenario with no SOC improvement.



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Temperature sensitivity changes induced by improved SOC in dryland (aridity index ≤0.65) and non-dryland (aridity index >0.65) regions for

maize (a) and soybean (b) during 2050–2080. Box plots show the 25th and 75th percentiles across 37 general circulation models (GCMs),

with whiskers representing the 10th and 90th percentiles.

The line and circle within each box indicate the multi-model median and mean values, respectively.

The Innovation

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REVIEW

OPEN ACCESS

Integrated strategies for enhancing agrifood productivity, lowering greenhouse gas emissions, and improving soil health

Li Wang,[1,2,3,*] Gina Marie Garland,[4,5] Tida Ge,[6,7] Shiqian Guo,[8] Endalkachew Abebe Kebede,[9] Chengang He,[10] Mohamed Hijri,[11,12] Daniel Plaza-Bonilla,[13] Lindsay C. Stringer,[14] Kyle Frankel Davis,[9,15] Soon-Jae Lee,[12,16] Shoujiang Feng,[1,2,3] Li Wang,[1,6,7] Zhenyang Wei,[1] Hanwen Cao,[1] Zhi Wang,[1] Jiexiong Xu,[1] Kadambot H.M. Siddique,[17] Gary Y. Gan,[1,2,3,18,*] and Min Zhao[1,2,3,*]

*Correspondence: li.wang@wzu.edu.cn (L.W.); gary.gan@ubc-soil.ca (G.Y.G.); zmcn@tom.com (M.Z.)

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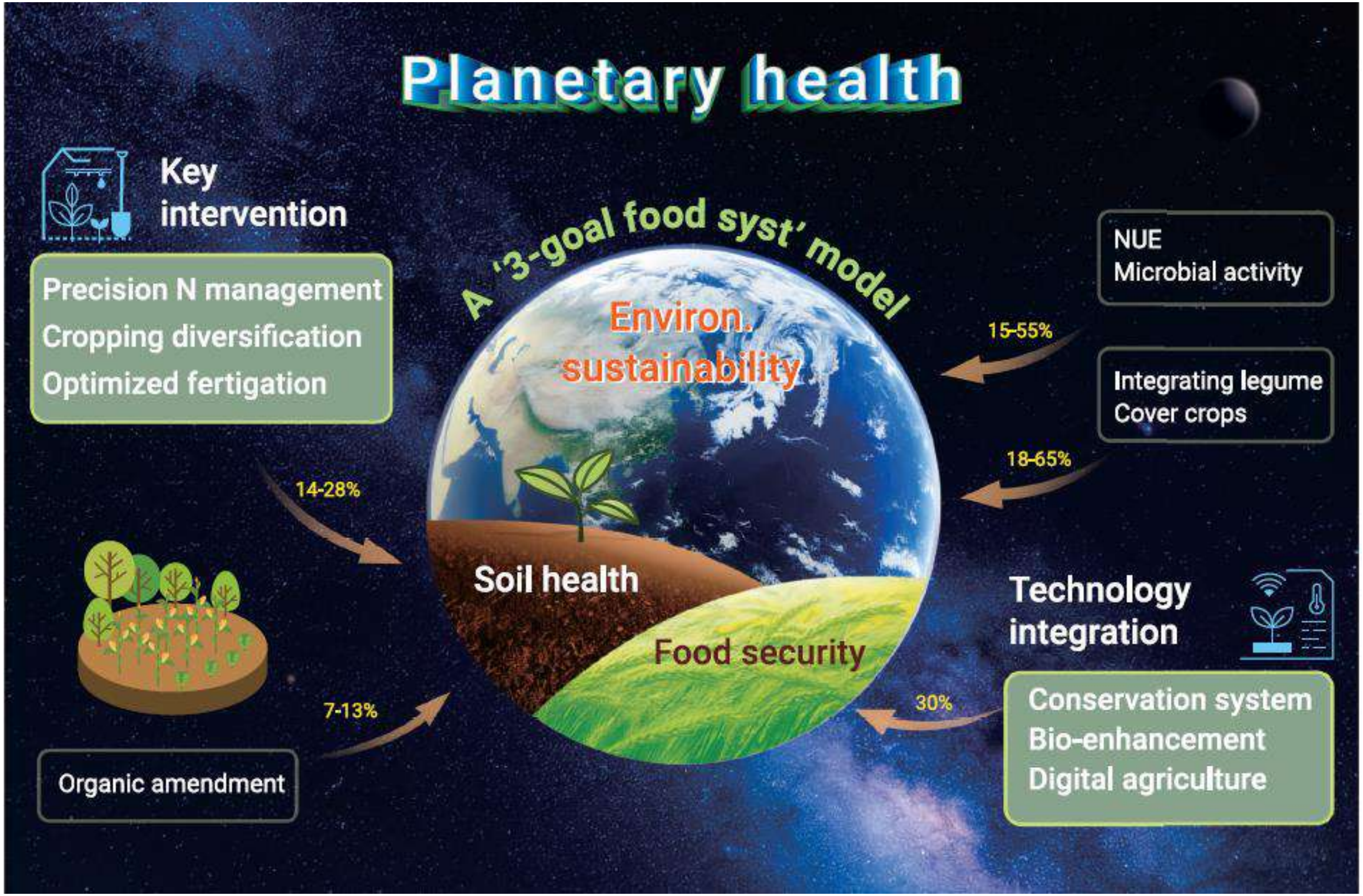
PUBLIC SUMMARY

- Integrated cropping strategies can simultaneously enhance food production, reduce emissions, and improve soil health.
- Enhancing plant-soil-microbe interactions can enhance agroecosystem resilience by 15%–40%.
- Prioritizing CO_2 fertilization, along with biofertilization, can cut greenhouse gas emissions by 30%–50%.
- Legume-cereal intercropping can enhance system productivity while reducing environmental footprint.
- Second-order meta-analysis can synthesize comprehensive research to solve interlinked issues.



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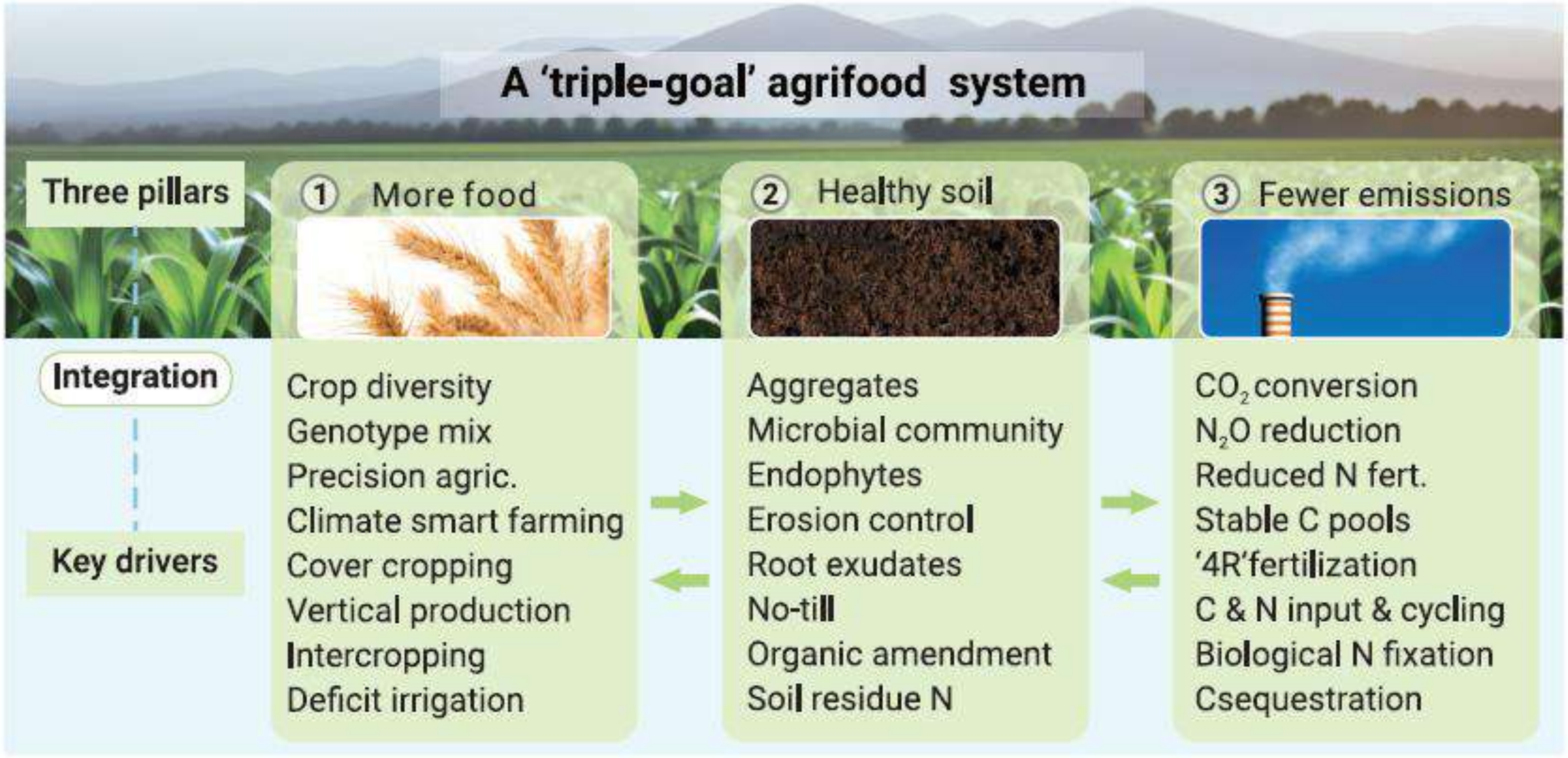
Integration of the three pillars – more food, healthier soils, and fewer emissions – within the triple-goal agrifood network



Four Industrial Revolutions

Source: Agricultural Decision-Making meets the Fourth Industrial Revolution, Dr Andrew Moore, CSIRO 2018

Digiscape Future Science Platform

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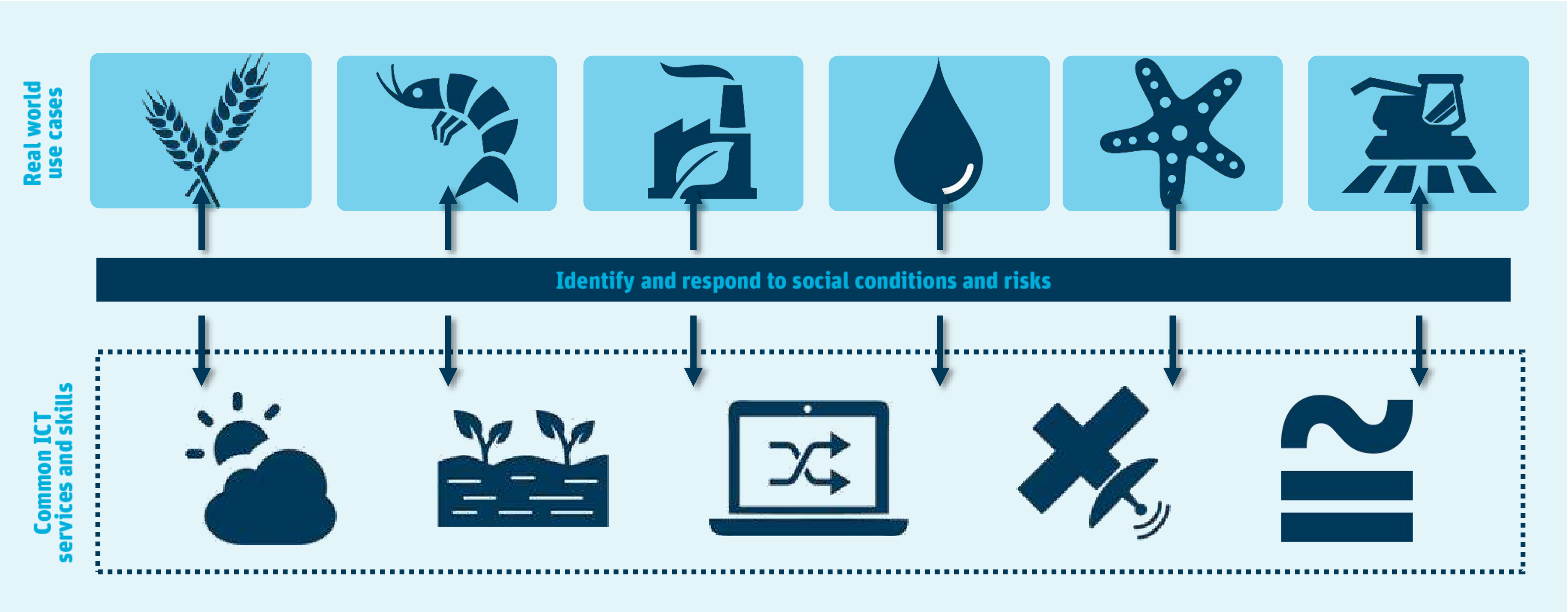
Harnessing the digital revolution for farmers & land managers



Source: Agricultural Decision-Making meets the Fourth Industrial Revolution, Dr Andrew Moore, CSIRO 2018

Levels of adaptation in relation to benefits from adaptation actions and degree of climate change

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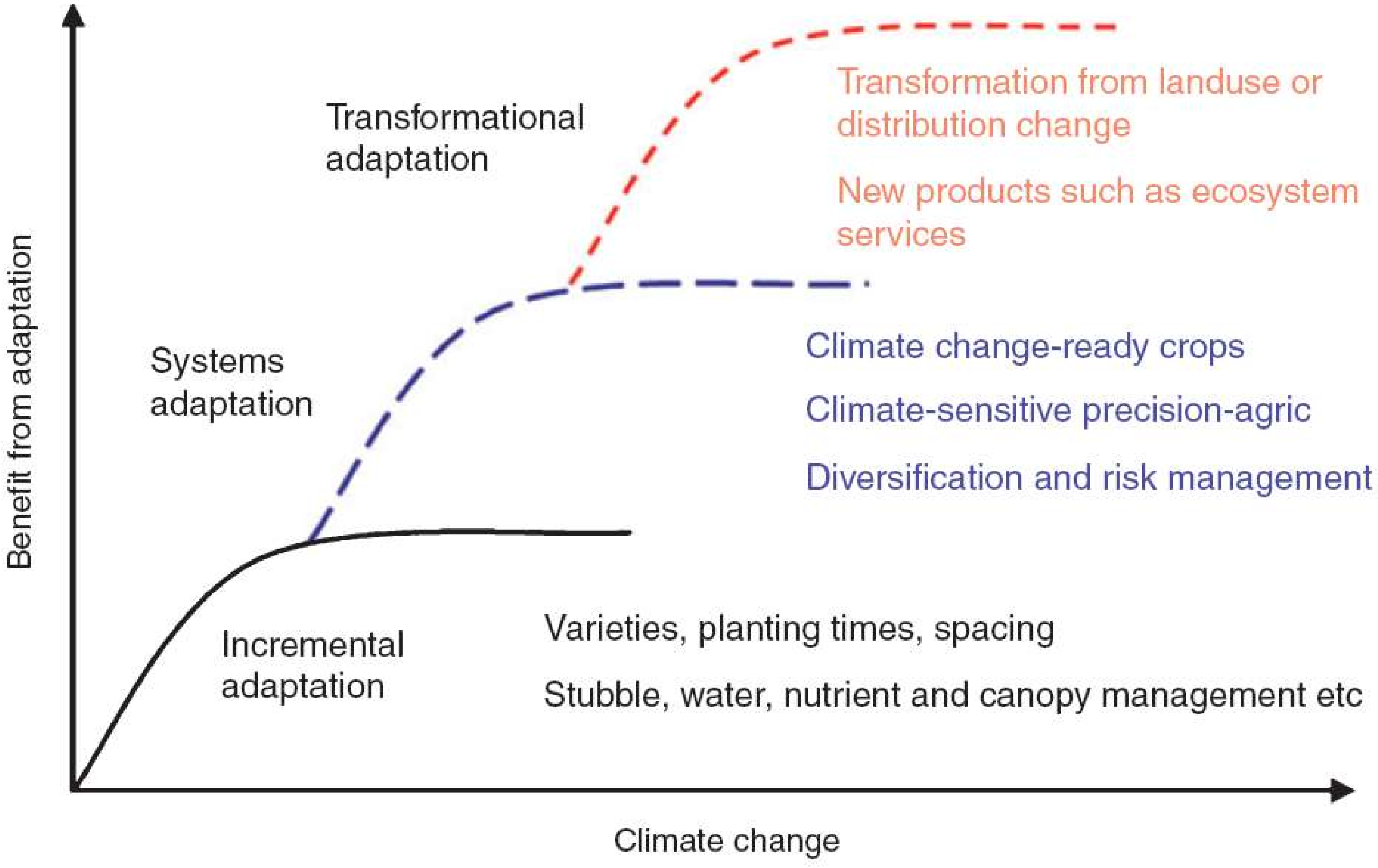

Source: Crop & Pasture Science L. Rickards and S.M. Howden 2012

Strategies for Enhancing Crop Production

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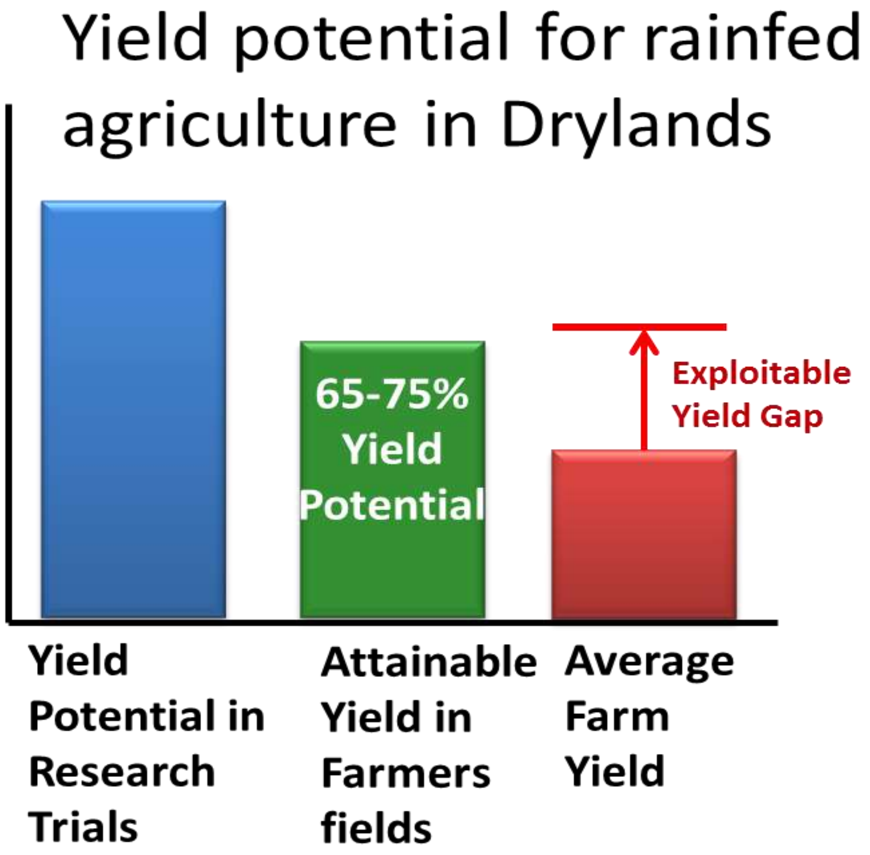
- Vertical increase in productivity through sustainable intensification of production systems
- Closing the yield gaps
- Crop genetic improvement and new genetic gains for improved varieties
- Horizontal expansion
- Reduced post-harvest losses



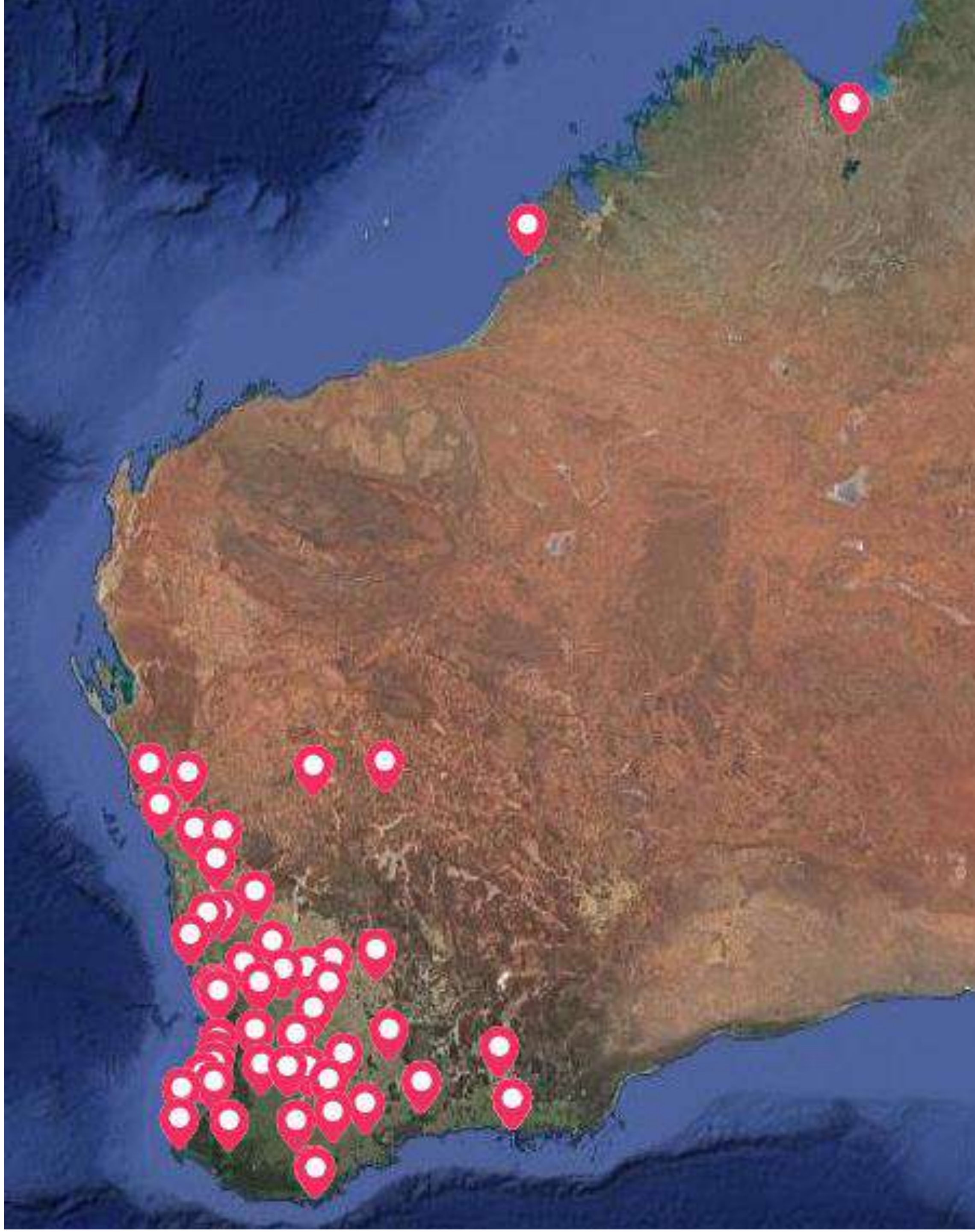
- **25-60% yield gaps in crops**
- **Reasons are many…Farmers participatory research and development is urgently required**

GROWER GROUP ALLIANCE
Together we grow

GGA Network

Over 60 Grower Groups in the network representing around 4,000 producers

State-based, non-political, producer voice for members from all sectors of the industry focussed on RD&E



The Voice of the Agricultural Industry

"Adaptation will only take us part way in dealing with the impacts of climate change. More fundamentally, Australia needs to tackle the root cause of climate change, human sourced emissions of greenhouse gases. This will mean giving priority to mitigation".

"Adaptation alone will not be enough…it must be paired with a drastic and urgent reduction in global greenhouse emissions if we're to avert the extraordinary crises that unmitigated planetary heating would bring."

"Early adoption of sustainable practices also benefits businesses supplying food to export markets. In some markets this can create a competitive advantage for Australian products over those from other countries where climate change mitigation has not been pursued".

"Over the longer term, the most important actions that both businesses and governments can take will be to reduce emissions of greenhouse gases. Deep and lasting cuts in emissions in the food supply chain will deliver long term benefits to consumers, exporters, farmers, food manufacturers, retailers, and the many other businesses involved in food production and distribution".

Source: Fork in the road. farmers for climate action

Indian Agriculture Sector

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The Indian agriculture sector is a **significant contributor to the country's economy:**

Projected market size of **INR 67,406.43 billion** by **2034**, growing at **a CAGR of 8.28%** .

Indian Agriculture Sector

Key Areas with Huge Potential

Horticulture: This sector is expected to grow, driven by increasing demand for fruits, vegetables, and other horticultural products. The sector's production is **355 million tons.**

Livestock and Fisheries: The livestock and fisheries sectors are emerging as robust growth drivers, contributing significantly to agricultural GDP and employment.

Organic and Sustainable Farming: There's a growing demand for organic and sustainable farming practices, with the organic farming sector expected to expand significantly.

Agri-Tech and Mechanization: Adoption of Agri-Tech and mechanization is expected to improve productivity and efficiency in the agriculture sector.

Export-Oriented Production: India has opportunities to increase exports of agricultural products, particularly horticultural produce, to countries like the US, EU, and Middle East.

Climate Shocks and Poverty in India

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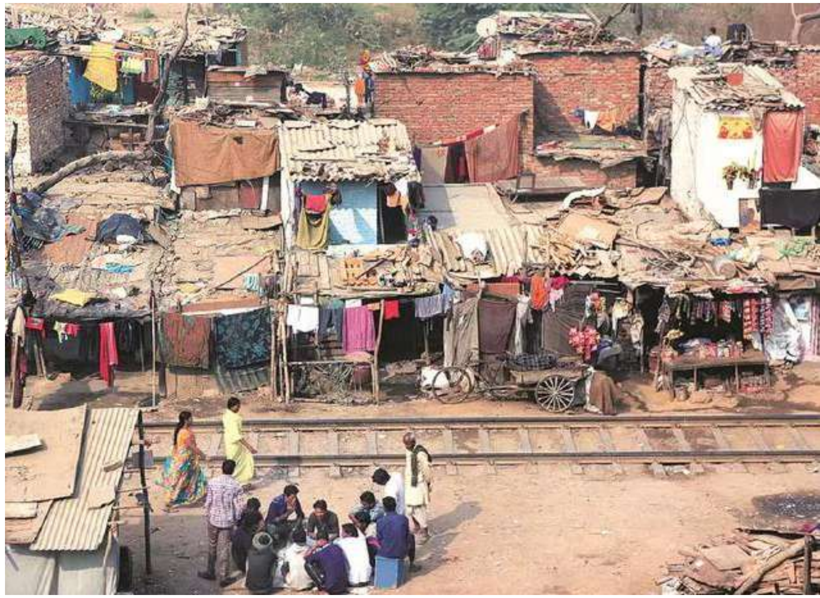
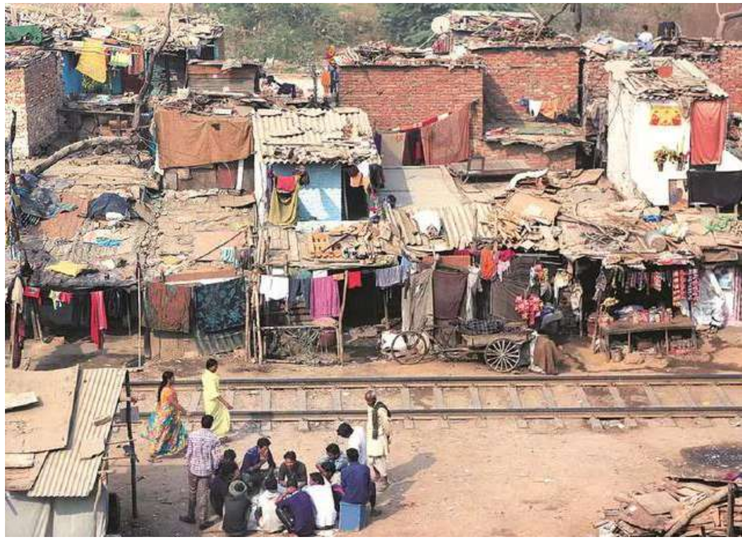


- Study by National Institute of Science Education & Research (Niser) across **593 districts in 21 states**
- Poverty increasingly **climate-driven**, not just economic
- Key climate shocks:
  - *Erratic **rainfall***
  - *Rising **temperatures***
  - ***Floods & droughts***
- **Temperature variability** is the strongest driver
  - ↑ temperature variation → **+31.1% probability of poverty**
- **Floods and rainfall variability:**
  - Flood exposure → damages crops, infrastructure
  - Uneven rainfall → reduces agricultural productivity
- **Agriculture-dependent districts most affected**

Source: Business Standard 12 Apr 2026

Drivers, Impacts, and Policy Implications

- **Drought + agriculture dependence →**
  - Districts **83% more likely to be poor**
- Social vulnerability:
  - Higher **Scheduled Tribe (ST) populations** → higher poverty risk
- Economic structure matters:
  - Strong **tertiary (service) sector** → reduces poverty
  - Diversification improves resilience



Policy recommendations:

- Promote **climate-resilient agriculture** (drought-resistant crops, innovative agronomy, smart irrigation)
- Expand **non-farm employment** opportunities
- Strengthen **disaster management systems**
- Use **region-specific policies** instead of one-size-fits-all approaches

Source: Business Standard 12 Apr 2026

Wheat output may drop to 110-120 mt

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- India’s wheat production for the 2025–26 crop year is expected to be 110–120 million tonnes.
- The estimate was given by Food Secretary Sanjeev Chopra.
- The reduction is mainly due to unseasonal rains and hailstorms affecting major wheat-growing regions.

Wheat Output may Drop to 110-120 mt: Food Secy

Our Bureau

New Delhi: India's wheat output for the 2025-26 crop year is expected to drop to between 110 mt and 120 mt due to unseasonal rains and hail storms in the key producing regions, food secretary Sanjeev Chopra said on Friday.

The Roller Flour Millers' Federation of India has estimated production at 110.65 million tonnes, marginally higher than last year's 109.63 million tonnes, factoring in weather-related losses.

Earlier, the agriculture ministry had projected output at 120.21 mt, up from 117.94 mt before the conditions turned adverse.

"The figure given by the agriculture ministry was 120 mt, but that was prior to the rainfall... The reality will be somewhere between 110 million tonnes and 120 mt," Chopra said, addressing an event organised by the federation.

Chopra said the final figure is likely to fall between these estimates. He said government wheat procurement has reached 16.4 mt, with target raised to 34.5 mt from 30 mt.

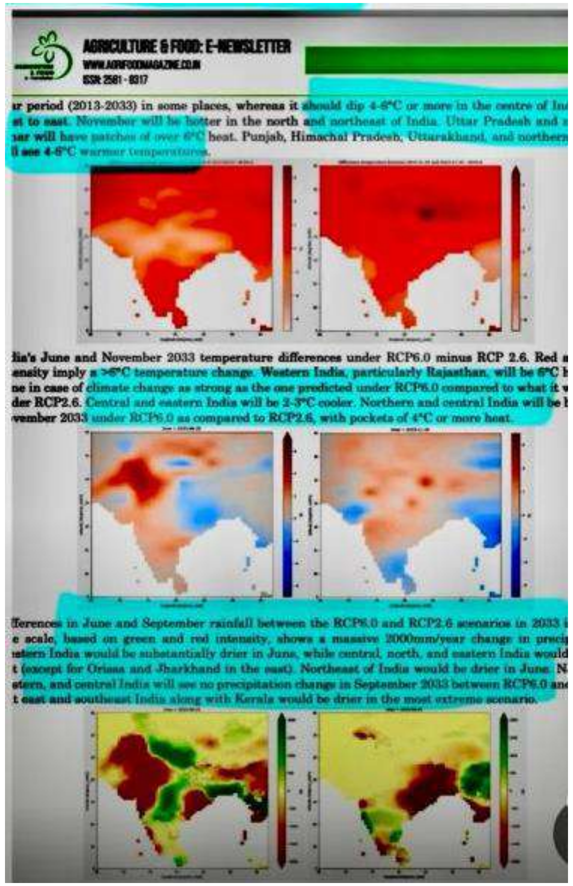
Procurement goals have been increased across Madhya Pradesh, Uttar Pradesh, Rajasthan, Bihar and Uttarakhand, with norms eased in all except Uttarakhand to facilitate buying.

The Centre has also cleared phased exports of 5 mt of wheat and 1 mt of wheat products, though shipments have remained subdued due to pricing constraints.

Source: The Economic Times

Wheat output may drop to 110-120 mt

The projected decline in India's wheat output to 110–120 million tonnes is **not merely a seasonal aberration**—it is a **structural warning**. It signals that prevailing **Indian wheat varieties lack sufficient climate resilience, particularly the genetic capacity to withstand rising temperature shocks** and unseasonal weather events under an accelerating climate change regime.



At this critical juncture, India must transition from reactive adjustments to anticipatory agricultural planning:

- Systematically capture and document climate-induced shifts
- Deploy AI-enabled crop intelligence for real-time advisories
- Promote region-specific crop diversification strategies
- Incentivize climate-resilient crops aligned with future conditions

Source: Agriculture & Food agrifoodmagazine.co.in

National Priorities for Grand Challenges in Agriculture-India

National Priority	Targets
1) Farmers Income	200%
2) Reducing Fertilizer Use	25%
3) Increasing Renewable Energy Use (Green Energy)	50%
4) Reducing GHGs Emission Intensity (Paris Agreement)	45%
5) Rehabilitation of Degraded Lands by 2030 (UNCCD)	26 M ha
6) Agri. Exports (Startups)	200%
7) Cooperative Farming (FPOs)	10000

Grand Challenge Focus
1) Climate Change
2) Food for Health and SDGs
4) Small Farm Mechanization
5) Secondary Agriculture (Process/Value)
6) Water Crisis/Biodiversity Conservation
7) Net Zero Emissions (2070)
8) Implementation of NEP/Skill India
9) Agri Job Creation-Value Chains
10) Food Loss Reduction
11) Efficiency of Human Resources/Gender
12) Resources/Collaborations/Networks

IARI

Indian Agriculture Sector

Areas Needing Exploration

Crop Diversification: Encouraging farmers to diversify their crops can help reduce dependence on traditional crops and increase profitability.

Value-Added Products: Focusing on value-added products, such as processed foods and agri-exports, can enhance farmer incomes.

Climate-Resilient Agriculture: Developing climate-resilient agricultural practices can help mitigate the impact of climate change.

Conclusions

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Adaptation to climate change: R,D&I

1. **Understand past changes and past adaptation, improve systems understanding, quantifying impact of change**
2. **Understand future climate change (regional downscaling, uncertainty & risk management)**
3. **Specific breeding:**
   - Increase WUE (also good now!)
   - Increase heat resistance (more critical in future)
   - Maximise benefits from elevated CO_2 (ignored in past!)

Conclusions

4. Seasonal forecasts (rainfall, extreme T) – is needed now, but even more critical in future
5. Thresholds & critical events (e.g. more or less erosion with climate change?); new weeds, pests & diseases
6. Communicate with farmers what we know & do not know

Seeing nothing;

hearing nothing;

& doing nothing

is no longer an option